Referee Comments on
Title: A new ENSO index derived from satellite measurements of column ozone
Author(s): J. R. Ziemke et al.
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This paper defines a new ENSO index using satellite measurements of total column ozone, based on the finding that total column ozone variability in the tropics results mainly from variations in tropospheric ozone, which varies systematically with ENSO. The paper is well written and clear, and the analysis methods are fully explained. It is a suitable topic for publication in ACP, and, to my knowledge, it represents original work. However, I raise a few concerns below that I feel should be addressed before publication to improve the value of this contribution to readers.

General Comments

1. The motivation of this work is not clear. Although the method is clever, what is the purpose or value of a new ENSO index? Why is it important to have an index based on tropospheric ozone of a phenomenon that involves interactions between the tropical ocean and atmosphere and that is manifested in meteorological and sea surface conditions? The idea that this might be useful for evaluating climate models needs better justification. Has any modeling study ever identified a need for such an index?

2. The reliance on satellite observations both limits the potential period of record and misses an opportunity to evaluate the tropospheric ozone variability associated with ENSO. Did the author's consider using in situ ozonesonde or Umkehr data to assess directly the ENSO signal in tropospheric ozone?

3. The idea, expressed in the abstract, that the spatial differencing procedure used to compute the new index is an important aspect of this work is a bit misleading. Many ENSO indices (including the classical Tahiti-Darwin surface pressure difference) are based on spatial differences, as are many indices of other modes of climate variability.

4. The paper introduces a bunch of new and unnecessary acronyms that confuse the reader, rather than make the paper easier to read. For example, TCO is meant to be tropospheric column ozone, but I misread it more than once as total column ozone. AO is used for annual oscillation, but is easily read as Arctic Oscillation. For ozone, I suggest using subscripts (strat, trop, total) to avoid confusion, and avoid other new acronyms as much as possible. The abstract, in particular, is full of undefined acronyms, which should probably be spelled out.

5. The paper is also full of jargon that is probably familiar to specialists in satellite observations of ozone, but is baffling to the rest of us. Specific examples are given below.

6. Finally, the authors have focused on ENSO, which is but one of several modes of global climate variability. Have they also considered developing ozone-based indices of other modes, such as the Northern (or Southern) Annular Mode? These extratropical modes might be even more

interesting to examine in the context of understanding dynamical contributions to ozone variability.

Specific Suggested Changes

The Introduction would benefit from inclusion of references to classical ENSO literature and to papers dealing specifically with the issue of developing indices for complex modes of climate variability. Also, it would be good to cite references showing a relationship between ENSO and trace gas distributions.

L53 – "obtained via the internet" is not a sufficient reference for datasets.

L56 – Doesn't CO2 also show an ENSO signal? And is this related to atmospheric changes or to carbon fluxes to/from the tropical ocean?

L96 – Define "level-2"

L111 – "TOMS webpage" is not a sufficient reference.

L112 – What is "the v8 algorithm" – a recipe for a canned beverage?

L113 – What are "UV cloud pressures"?

Section 3 needs to discuss the precision and accuracy of the observations since the results are given to the ~ 1 DU level. Are the data reliable to that level? Section 3 (~L118) should also discuss the horizontal resolution of MLS data, and the implications for detecting an ENSO signal. Does the large MLS "footprint" impact the spatial differencing?

L148 – Sentence is unclear. Is deep convection or low boundary layer ozone the explanation of low ozone concentrations in the troposphere?

L163 – The 5 DU zonal changes in stratospheric ozone should be compared with mean values to give the reader a sense of their importance; perhaps percentage changes would also be informative.

L171-2 – Is this an assertion, results from prior research, or results from this study?

L210 – "updated" from what, and how?

L216 – "excessive eddy transport" - Please define the type and scale of the eddies in question.

L225 – Why was 1979-94 the period of simulation?

L235 – Isn't a third factor the small zonal variation in ozone production and destruction?

L242 – Is the use of Dobson Units/km standard, or are DU usually used for (even defined as) total column units? I'm not familiar with this way of expressing an ozone gradient.

L239-252 – Perhaps this whole paragraph is unnecessary, as the "important result" stated in the final sentence is actually already discussed in the preceding text.

L258 – Why choose Oct 2004-mid 2009? Was this the period of maximum overlap of the datasets?

L285 – Should the 1986-87 event be included in the list?

L293 – Please provide details of the "data mining method", so that others might be able to reproduce the results. So much detail is given about other aspects of the analysis that this obscure part stands out.

Section 5 Summary could be dramatically shortened by providing a more succinct summary of the results and avoiding repetition of material from other section.

L366-7 – Is this shown in the paper? If not, either give a reference or avoid speculation.

L378 – In addition to the NASA web page, the dataset should be published in ACP along with the article. It is a fundamental result of this work and so should be published along with the methodology.

Fig 1 caption should include time period and contour spacing, as some contours are illegible.

L531-2 repeats material in main text unnecessarily.

Fig 7 time axis should be in 4-digit years and should not be labeled "Month". Also, caption should be clear about whether these are model or observational data.

L571-3 not needed in figure legend.

Figs 9 and 10 could be combined.

END