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Earth System Dynamics
Discussions

Interactive comment on "Current rapid global temperature rise linked to falling SO_2 emissions" *by* Nick E. B. Cowern

Anonymous Referee #2

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This manuscript presents an analysis of global mean surface temperature trends, and identifies major changes in climate forcing during the last 1-2 decades. In particular the paper finds a >50% decrease in SO2 emissions from large sources during the last 6 years has reduced tropospheric aerosol cooling and thereby caused an acceleration of anthropogenic global warming. Furthermore the paper finds ocean-atmosphere heat exchange does not contribute substantially to 21st century warming trends, once trends are corrected for ENSO variations.

The article addresses a very important topic, identifying the extent to which tropospheric aerosol forcing, volcanic aerosol and internal climate variability are drivers of observed climate variability in recent decades. However, several of the findings from the paper are already established, for example it is well known that major changes in

climate forcing have occurred in the last 1-2 decades, this is not a new finding. The paper does not, in its current form, put the research into sufficient context with regard to other research to attribution the drivers of recent climate change. In particular, the Introduction section is very weak, only 1 paragraph (lines 24 to 28) explaining the context of the research with no citations of previous research in this area. The rest of the Introduction explains this paper, with only very brief and vague mention of other literature findings.

Overall I was struck that the paper read more like a draft of a graduate student dissertation rather than a paper for peer-reviewed journal and the manuscript requires much more work to explain the methods more clearly, and what additional information they bring for example compared to other similar studies. In particular compared to findings from detection and attribution studies to fingerprint the climate responses to different forcings from climate model integrations (e.g. Hegerl & Zwierz, 2011), as in the current community activity DAMIP (Gillett et al., 2016), alligned to CMIP6.

Also, in several places there are incorrect, inaccurate or unsupported statements in the manuscript (see e.g. specific comments 1, 4, 5) which need to be adequately caveated or better qualified with supporting evidence/reference. In particular, the context of this paper within findings in chapter 10 of the IPCC AR5 climate assessment report (Bindoff et al., 2013) need to be much better explained.

For the above reasons, the paper requires fundamentally re-writing, I am therefore recommending the paper be rejected and re-drafted before re-submission.

Specific comments ————

1) Abstract, lines 5-6: This first sentence may be correct for some periods of the historical record, but it is certainly not the case during periods of strong volcanic activity (e.g. Santer et al., 2014). Also, the starting 5 words "It is widely held that.." is an unscientific way to begin an article, it may be potentially OK if those words were replaced by "Outside periods of strong volcanic activity...". Perhaps adding "slowly-varying" or

similar before "changes in external forcing" may potentially also help explain what is being contended here. However, since this directly relates to the topic of the article, and the given timescale here is out to a decade, I would advise to keep this statement more open.

2) Abstract, lines 9-11 – the main evidence supporting the papers findings stems from an analysis to compare ENSO-corrected global mean surface temperature trends with a new temperature metric that corrects for changes in ocean heat content (OHC). But the timescales for this central methodology need to be stated here in the Abstract and the reader given more information re: the "scaled OHC", otherwise they will remain yet to be convinced.

3) Abstract, lines 13-19 – The authors refer to isolating the underlying signal of anthropogenic global warming, but again the timescales are unclear here. Related to this, the apparent slowdown in surface warming is referred to as "from late 1990s to 2011" which has one-year uncertainty at end of the period but multiple-year uncertainty at the start of the period. The language used for these statements needs to be sharpened up substantially and the proposed link between recent SO2 emissions decreases and the link between the more rapid warming in observed global mean surface temperature trends in the last 5 years and a decrease in tropospheric aerosol cooling needs to be more than just the timing of SO2 emissions. Reducing SO2 emissions does not necessarily mean less tropospheric aerosol cooling, for example due to ammonium nitrate aerosol forming more effectively as SO2 emissions decrease (e.g. Hauglustaine et al., 2014), and the influential role of anthropogenic organic aerosol (e.g. Tsigaridis and Kanakidou, 2018).

4) Introduction, page 2, line 1 – what is meant by a measure of temperature being "potentially dependent on non-ENSO climate variability"? The sentence does not seem to make sense. Also, the authors contend the ENSO-corrected global mean surface temperature record is then independent of all internal climate variability. The paper needs to explain other sources of inter-annual climate variability such as the North

Atlantic Oscillation, and to also explain the role of decadal internal variability in the Atlantic (the Atlantic Meridional Oscillation, e.g. Sutton and Hodson, 2005) and in the Pacific (the Pacific Multidecadal Oscillation, e.g. Meehl et al., 2008).

5) Section 2.1, page 3, lines 16-18 – the wording is extremly vague, such the reader is not clear which time-period is ebing discussed here. Furthermore the statement "decadal variations caused by changes in climate forcing have been thought to be small". This statement is so clearly false, since greenhouse gas forcing, with offset from cooling from increased tropospheric aerosol forcing is very well established in successive climate assessment reports to be the primary drivers of climate change in the last 5 decades.

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