

We would like to thank **Reviewer #1** for the insightful kind comments and suggestions. Please find our replies.

**Main comments:**

This is a wonderful paper that will provide many future generations of atmospheric scientists some perspective on how the field developed and its current status. The limitations and approach taken are clearly stated and their emphasis on integrating all aspects of the field, ambient measurements, lab studies and modeling, is terrific. This reviewer has just a few suggestions and minor typo's etc.

1. Line 34: Suggest adding at least one other review from the health community re: human health impacts, e.g. by Landrigan et al in Lancet, 2018. The introduction says it is only treating papers 2010 and earlier but cites a 2015 Lelieveld paper for health effects so I assume later papers than 2010 are being cited for background?

The reference Landrigan et al, 2018 has been added and wider contextual papers post 2010 are in scope..

2. Throughout, the word "aerosols" is used to denote "particles". Historically, the engineers who developed much of this area and the instrumentation have defined aerosols as particles and the gas in which they are suspended (e.g. see Hinds book). This would be a good place to exhibit consistency and use "aerosol particles" throughout, or just "particles" if that is what they mean.

The text has been changed as recommended.

3. Line 360: As the authors indicate in the introduction, the fundamental work on which significant advances are made often ends up not being cited as the field develops. The laser ionization MS technique I think originated with Sinha, Rev. Sci. Instrum. (1984), followed by papers coauthored with Friedlander. It might be appropriate to include one of these references along with Prather and Murphy.

The reference Sinha et al. 1984 has been added.

4. Line 367: I would add for clarity at the end of the sentence on this line "that assumed low viscosity, liquid-like particles where exchange with the gas phase is fast".

The text has been changed as recommended.

16. Line 445: They state that the "distinction between heterogenous and multiphase chemistry is not always clear". This would be a good place to define these terms.

A reference (Ravishankara, 1997) that discusses this distinction has been added to the text.

17. Lines 453-469: These two paragraphs mix multiphase and heterogenous chemistry in a somewhat random order. I think they are using "heterogeneous" to mean reactions at surfaces and "multiphase" to mean reactions involving the uptake of gases into (and reaction in) the liquid phase. It would be good to define the terms first and then separate out the examples they give into the two bins.

The sentence "Often "heterogeneous" is taken to mean reactions at surfaces and "multiphase" to mean reactions involving the uptake of gases into (and reaction in) the liquid phase." has been added to the text.

18. Line 455-459: This cites the work of Akimoto et al on the photoenhancement of HONO formation but it seems some discussion of the dark formation of HONO should come first. The Pitts et al, *Int. J. Chem. Kin.* (1984) might be the first discussion of this in chambers. Finlayson-Pitts et al, *PCCP* (2003) is a review of the area to that point.

References to the work of Pitts and Finlayson-Pitts have been added to the text.

19. Lines 571-573: It reads as if Sillman (1999) was the first to put together ozone isopleths but this goes back into the 1950's or 60's, probably Haagen-Smit and Fox (1954). It would be good to cite the origins here as it is so important to our understanding even today.

The sentence has been clarified to point out that Sillman drew on previous work.

20. Lines 685-692: Shroeder and Urone (EST, 1974) were probably the first to suggest sea salt reactions as a photochemical source of chlorine atoms. It could be cited here and on line 704. A review by Cicerone in *Rev. Geophys. Space Phys.* (1981) would be a good review too.

Both references have been added to the text.

21. Line 846: It seems odd to state that emission inventories were pioneered in the 1990's. Surely they were being developed long before that, at least in California?

While it is true that emission inventories were developed earlier, we note that their growth and widespread application took place in the 90s.

22. Lines 925-927: Satellites have been really useful for tracking dust events but it seems that either here or in another section a reference to the seminal studies on dust transport of Prospero et al in the 1970's should be included.

Reference to Prospero's work in this area has been added to the Satellites section.

23. Line 988: "by now phased out the ozone-depleting gases". I think this is overly optimistic to say this, given recent measurements showing there seem to be emissions from Asia that were not expected. Maybe "are now phasing out ozone-depleting gases"...

The sentence has been changed to "are leading to the phasing out of ozone-depleting gases".

24. Table 1 seems quite Euro-centric, for example not including some of the big smog events in the U.S. and the passage of the Clean Air Act etc.

US smog events are included in the table, and the Clean Air Act is mentioned. While we recognize that the Table is Euro/US-centric some international landmarks are mentioned (e.g. Mount Pinatubo, Kyoto and Montreal protocols, etc...)

25. Table 2 is in two parts. It was not clear to this reviewer how they differ from each other in what they are supposed to illustrate.

The two parts of the table (it is actually Table 2) are derived from two different databases (Web of Science and Scopus), reflecting slightly different indexing methods. This is indicated in a new caption.

26. Table 3 seems out of context. It is very detailed on NO<sub>x</sub> but similar detail is not given for other species. I suggest omitting this.

We think Table 3 is an important finding of one of the landmark papers on the subject of nitrogen chemistry, outlining the complete nitrogen budget for the first time, so we would like to keep it in the paper.

27. Appendix 1 data go to 2020. Since the focus of the article is 2010 and prior years, some comment in the captions might be appropriate.

The 2010-2020 data are included to provide context. This has been clarified in the caption.

#### **Minor typos, grammar etc:**

1. Line 34: impacts.
2. Line 35: "latterly links to their climate" is very awkward. Maybe replace "latterly links to their climate" with "and climate"
3. Line 178: "pollutions"
8. Line 626: "any" should be "many"?
9. Line 824: "...most cited paper-"
10. Line 885: Should "The study" be omitted so the sentence starts: "Moody et al (1998) ..."
11. Line 900: Spelling error "emmitted"
12. The formatting of the references (no space between etc) makes them very hard to read but I suppose that will get straightened out in the final document.

The text has been amended as indicated.