

Responses to Cathy Clerbaux

1. This paper focuses on validation of the TES ozone profiles with a series of coincident ozonesonde observations. The comparison uses version 3 and 4 of the TES retrieval of ozone from spectra recorded using the stare observation mode, along with ACTIONS sondes measurements taken during the ARCTAS arctic field campaign.
2. Validation of satellite observations is an important step for further use of the remote sensed data. The paper provides a careful description of how the comparison was performed, and identifies some systematic bias for the TES ozone profile, in agreement with findings reported by previous publications. Using a stringent time and space coincidence criteria, the study shows that TES ozone profiles are reliable above 60°, and that the calculated errors are consistent with the observed errors.
3. I found the paper well written and useful, and I recommend its publication in ACP. I only have some minor remarks that could help to improve the clarity of the manuscript: [We appreciate the referee's comment.](#)
4. General comments - How can you be sure that the sounded air masses are about the same? The stare mode is at nadir only? [a\) Over the course of a measurement, an ozonesonde undergoes horizontal drift; therefore, the exact separation between the TES and sonde measurements may differ from the stated distances, which are based on the position of the sonde station. Worden et al. \(2007\) and Nassir et al. \(2008\) used 55 and 1600 TES-sonde coincidences, respectively, with a time and distance separation of \$\pm 48\$ h and a 800 km radius and \$\pm 9\$ h and a 300 km radius, respectively, from the sonde station, while we use a time and distance separation of \$\pm 3\$ h and a less than 1 km radius from the sonde station. We are confident that, despite the horizontal drift of ozonesondes, the TES stare—ozonesonde measurements are measuring 'roughly' the same air masses. This is illustrated in the plots comparing the TES Ozone Average, ozonesonde data, Sonce with the TES Operator applied, and the A Priori. b\) The TES Stare observation mode is done in nadir mode only.](#)
5. - Results are provided both for version 3 and version 4 of the data: 1/why both? Isn't V4 supposed to be an improved version as compared to V3? 2/ the description of the improvement between the two versions is not provided, unless it is only the one step versus two steps retrieval process (page 27273) that differs? 3/ Both versions use a single a priori profile? [The validation for both version 3 and 4 TES ozone data was provided for completeness.](#)
6. - page 27270 ligne 16: The IASI instrument also measures ozone profiles, eg A. Boynard et al, ACP 2009. [This reference has now been added to the manuscript.](#)
7. - page 27270 l29: Here it is said that the validation used 40 observations, whereas on page 27275 ligne 2 it says 55. [This mistake has been corrected to read 55 observations.](#)
8. - page 27272 l2 Stare » stare. [This mistake has been corrected.](#)
9. - page 27274 l1: The end of the sentence is weird. [This sentence has been modified to read more clearly.](#)
10. - page 27274 l6-l10 check parenthesis. [All parentheses are correct in this section.](#)

11. - page 27274 l10: It is written that the launches were timed for the early afternoon overpass and in the Table all the launch time are between 18 and 23h? This sentence has been deleted as it unnecessarily creates confusion.
12. - page 27278: check equ. (8): check the indice of S (%?). This error has been corrected in the manuscript.
13. - page 27279 l4: Averaging » averaging. This error has been corrected in the manuscript.
14. - page 27279 l7-8 and 27280 l10-11: twice the same is said. This sentence has been removed as it is repetitive.
15. - page 27280 l25-26 end of sentence missing or parenthesis should be removed? The parentheses were removed as suggested.
16. - page 27282 l24: better characterisation of the surface= better emissivity for the RT calculation? Yes, this statement is correct.
17. - page 27284 l3: suggestion to put % values here, to be consistent with other values provided earlier same paragraph. This suggestion has been taken into account and incorporated in the manuscript.
18. - page 27284 l18: (3): previous studies did not used the global survey mode? The inclusion of 'Global Survey' has been made in the sentence as the previous 2 validation studies did use this TES retrieval mode.
19. - page 27285 l8-l10: any explanation for the positive bias. Worden et al. (2007), Nassar et al. (2008), and Richards et al. (2008) also report an overall positive bias in the troposphere. Worden et al. (2007) calculated the error-weighted differences between the sonde with TES operator and TES profiles, averaged for the upper and lower troposphere. The error weighting allowed them to test for correlations in the ozone differences, while accounting for the possible dependence on TES measurement errors, where they found only weak correlations for ozone differences with distance and time coincidence criteria, although this may have been sourced at the small number of comparisons. These low correlations suggested that the positive biases obtained in Worden et al. (2007) is dominant over differences that might be expected from horizontal-scale variations in the ozonesondes. Yet, Nassar et al. (2008) and Richards et al. (2008) suggest that the positive tropospheric bias is unrelated atmospheric variability, and the contribution to the bias from sondes (e.g., horizontal –scale variations) is small. Issues such as biases between different types of ozonesondes, or biases between sondes and other ozone measuring techniques will need to be understood better in order to make a good estimate of the contribution of the TES bias that should actually be attributed to the ozonesondes. Lastly, given that our theoretical and empirical random errors range from 5 to 15%, the positive bias observed in the troposphere (and biases in general) could also be attributed to some degree to smoothing, measurement, and systematic errors from interfering species, surface emissivity, atmospheric and surface temperature, and line parameter uncertainties.
20. find a way to distinguish the two Worden 2007. This suggestions has been taken into account and incorporated in the manuscript.
21. - Brasseur ref : tracewrs > traceurs. This error has been fixed in the manuscript.

22. - Jacob ref : 2009, » 2009. [This error has been corrected in the manuscript.](#)
23. - Osterman ref: Spectrometree (remove e). [This error has been corrected in the manuscript.](#)
24. - Thomson ref 2008, > 2008. [This error has been corrected in the manuscript.](#)
25. - Table 1 and Table 2 are very similar I would suggest to combine them. [We do appreciate Cathy's suggestion here, but we feel that the tables are suitable as is.](#)
26. - Table 3: How are the errors obtained as compared to profiles given in the plots?
summed over the vertical? [The mean bias, theoretical, and empirical random errors were quantified by summing respective values over the entire altitude range of measurements and taking the average of this sum.](#)
27. - Table 4: Caption similar to Table 3: should be V004 instead? [This error has been amended in the revised manuscript such that Table 3 refers to V003 TES ozone and Table 4 refers to V004 TES ozone.](#)