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Interactive comment on "A GPS water vapor tomography method based on a genetic algorithm" *by* Fei Yang et al.

Anonymous Referee #2

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General comments:

This paper proposes a new approach to solving GPS tomographic inversion to retrieve 3-D atmospheric water vapor distribution above a network of GPS receiving stations. It should circumvent the strong constraints of classical techniques that have to deal with the inversion of an often very sparse matrix. Hence, this approach could be of great interest to the community.

However, to demonstrate the good performances of their technique, the authors set to provide an ensemble of statistical indicators, some with respect to GPS slant delays, some with respect to radio-sounding profiles, some with respect to "classical techniques", etc. but usually considering only global RMS and MAE scores. Although statistical estimates are of interest, they do provide the physical/meteorological under-

standing of the actual objective (and challenge) of tomography inversion: it is the 3-D distribution of water vapor and more particularly its vertical variability. Hence, it would have been, in my view, much more informative and useful to the community to have comparisons of profiles of RS + ERA + GA + Least-Square + Ref GPS, possibly with the corresponding statistical metrics in order to perceive the actual capacity of the new technique to resolve the water vapor distribution, rather that producing a dispersed set of statistics which makes it difficult how the technique compares globally.

This article is globally well written and easily readable, nonetheless, the English phrasing is at times a bit awkward which might lead to some misunderstandings.

Specific comments:

P.5, L.8: after criteria, do you mean a "," or a ":"? i.e., are there 3 (",") or 2 (":") conditions for termination. In any case, a precise description of the termination criteria and how they are defined should be clearly stated here.

P.9, L.15: for clarity one could add something like "The change of tomography-computed VS GAMIT-estimated slant water vapor residuals"... Likewise, if this tells us that the GA method compares reasonably well with the original data, it would have been very interesting (and useful to evaluate the method) to know how would have fared a "classical" inversion technique.

P.9, L.17: "It is clear ... residuals decreased with ... elevation angle". Readers can read a graph. Hence, if that is stating the obvious, then the sentence can be deleted... otherwise, if that is a point of interest, than it should be discussed... Likewise with the following sentence: "The right ... angles".

P.10, L.11-13: Is there some altitude difference between the 2 stations? I would guess that if that is the case, hkmw is higher than hkpc. Actually, at this point, one could also discuss the reason why in fig 5 all zenith residuals are positive!

P.13, L.15-17: I guess this sentence relates to the green box plot of Fig. 8... but are

you sure that the range [-7.08, 4.47] is a sign of good water vapor restitution for the new method??? That is, I guess, what should be appreciated rather than a good statistical distribution!

P.14, Fig.9: it is a pity that the equivalent graphs for the no rain days are not provided. Indeed, the major limitation of GPS tomographic inversion is its ability to retrieve the vertical variability and that can only be assessed by profiles comparisons with RS, not by global statistics.

P.15, L.3-5: A this point, one could think in terms of relative error rather than absolute error.

P.18, L.7-8: If there are cases when GA performs better than lest square methods and others when it is the opposite, the authors should at least try to sort out if there are some "signature" to those contrasted behaviors (like the presence or amplitude of rain, the type of weather regimes, or more technical reasons such as GPS constellation configurations, . . . etc) in order to provide informative comments to the reader. Indeed, it is important to know how reliable the GA method is compared to the established least square ones: if it performs globally as well and is more computing effective, or performs better, than it is a real progress. If it under performs compared to others, than it has less interest.

P.19, L.10: The statement that GA can achieve good tomographic results is certainly true, but it should be discussed in light of the comment regarding the comparison with other methods (see comment above).

P.20, L.9-10: "more water vapor information exists in rainy weather"!!! That needs to be explained (or stated in an understandable way). In my view, weather conditions do not modify the amount of information but the value of such!

P.20, L.10-11: the sentence "Moreover . . . experiments" is unclear or seem unachieved. . . the reader expects something like "and . . ." to know what is the con-

sequence of making measurements during experiments!

P.20, L.18 and following: Indeed, neglecting water vapor above 8km in near tropical conditions is far from ideal as it much below the tropopause. Hence a significant part of the water vapor distribution (and dynamics) is not considered. That actually questions the adequacy of Rain / No Rain comparisons throughout the paper at this stage as it could be explained solely by the vertical development of cloud systems.

Technical corrections:

P.1, L.16 (and throughout the text): I think one should use the term "a priori" rather than "priori" information or data.

P.1, L.28: "and are . . ." this sentence is not grammatically correct and one wonders to what this part relates to.

P.2, L.3: I guess you meant "to improve the restitution of the spatio-temporal variations".

P.8, Fig.3: Isn't there a graph issue: why is the coloring not matching the grid, for example, in the last part of the figure, there are voxels with some black and some white in it while I understand from the text that it should be either black or white only.

Conclusions:

This paper introduces a new GPS tomographic inversion method. It has true scientific potential and should make for a significant contribution to the community. Although it has all the tools to provide the necessary informative comparisons to assess the performances of the proposed method, it lacks some key analysis at this point and should be reconsidered by the authors.

In conclusion, there is currently too much "global statistics" and too little "physical/meteorological considerations" for tomographic water vapor retrieval.

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