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Geoscientific Model Development Discussions

Interactive comment on "Optimization of an Urban Monitoring Network for Retrieving an Unknown Point Source Emission" *by* Hamza Kouichi et al.

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We thank Dr. Efthimiou for reviewing our paper and for the positive feedback. We appreciate his questions:

1. Why we don't directly compare results of 'optimal' network of 10 sensors with the results of other networks of 10 sensors?

2. Why we compare results of source inversion (distance to true source, etc.) with 'optimal network' of 10 sensors with the results obtained by the full network (40 sensors)?

Our responses to the specifics questions are listed below:

1. The comparison with networks of the same size (10 sensors for example), is per-

formed implicitly during the optimization process. The Simulated Annealing used in this study compares at each iteration two networks (of the same size) and retains the 'best one'. The networks are generated randomly as in Kovalets et al (2011) and Efthimiou et al (2017) and the comparison is based on the cost function named Normalized Errors 'Js' and inspired from the renormalized data assimilation method. This cost function quantifies the quadratic distance between the observed and the simulated measurements according to the normalized Gram matrix 'Hw'. The challenge was to design the networks without using a priori the parameters of the real source and without considering an acceptance criteria of networks quality (rH $\leq$ 15 m, rV $\leq$ 2.5 m, δq $\leq$ 4) as performed in Kovalets et al (2011) and Efthimiou et al (2017). Based on 'Js', the 'optimal network' produce the 'best' description of the observations (i.e. corresponds to the minimal quadratic distance between the observed and the simulated measurements) and permits a posteriori to reconstruct its origin. In the attached figures 1, 2 & 3 is presented the evolutions of the cost functions for trials 5, 11 & 19 during the optimization process. Since the search space is quite large so about 3E+04 networks of 10 sensors are compared.

2. The results obtained by the optimal networks of 10 and 13 sensors are compared with the original network of 40 sensors for two reasons: As in practice the number of measurements is very limited, this comparison allows us to conclude that in urban areas source reconstruction can be conducted with networks of limited number of sensors and to confirm that the reduction of networks size don't degrade significantly its efficiency. For more details, the choice of the number of sensors (10 and 13) is fixed after observing that an acceptable estimation of the source in majorities of the trials was enabled by using minimum 8 sensors. Also by using more than 13 sensors optimal networks, the errors in source parameters estimation are stable and does not improve significantly, Kouichi, (2017). For this reason, the optimization were constructed and evaluated for sizes 10 and 13 (1/4th and about 1/3rd of the original network of 40 sensors).

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2) G.C. Efthimiou, I.V. Kovalets, A. Venetsanos, S. Andronopoulos, C.D. Argyropoulos, K. Kakosimos, An optimized inverse modelling method for determining the location and strength of a point source releasing airborne material in urban environment, Atmos. Environ., 170 (2017) 118-129

3) Kouichi, H. (2017), Sensors networks optimization for the characterization of atmospheric releases source, Theses, Université Paris Saclay, France. https://hal.archives-ouvertes.fr/tel-01593834v2

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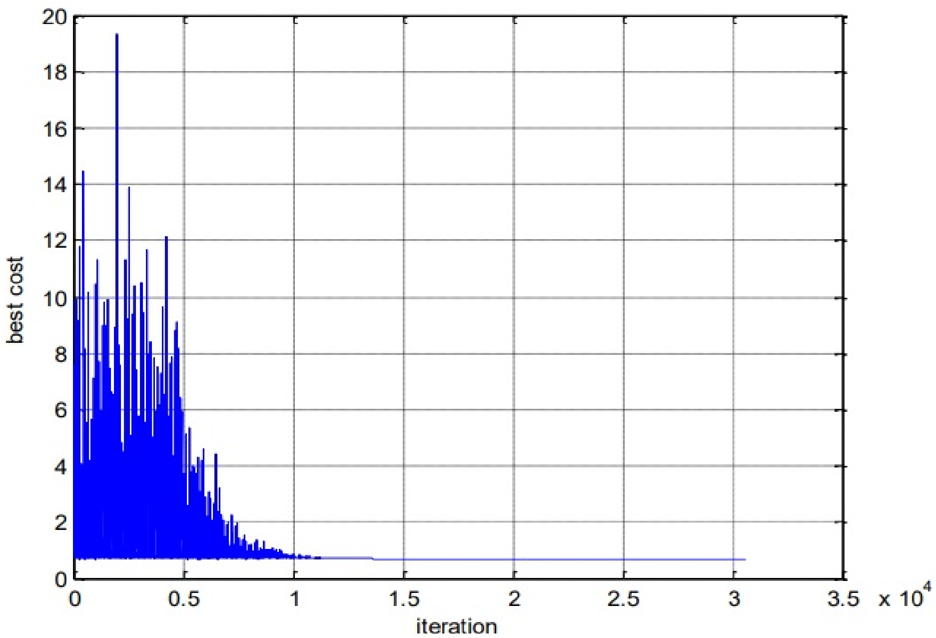

Fig. 1. Figure 1: Evolution of the cost function for trial 5

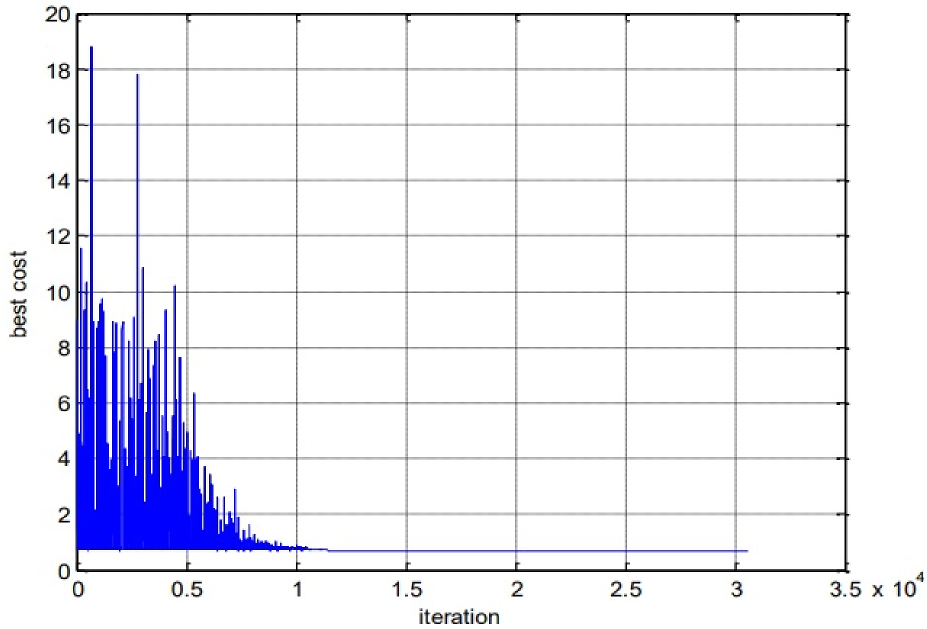

Fig. 2. Figure 2: Evolution of the cost function for trial 11

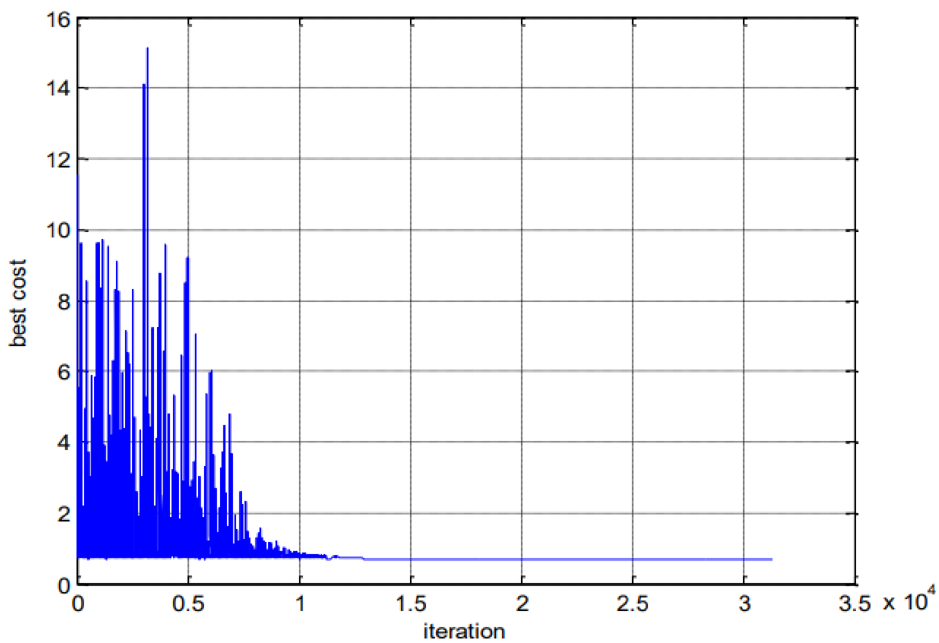

Fig. 3. Figure 3: Evolution of the cost function for trial 19