We would like to thank the referee for the review of this manuscript and their constructive comments. Our response to each comment is below with the referee's comments highlighted in italic typeface.

This is an excellent manuscript that describes a very useful new development. The approach is well introduced and the results are well presented.

Response: We are grateful for the overall positive assessment.

Nevertheless, I would appreciate, if the manuscript could address more in depth the basic idea (combining scientific and economic aspects in the context of network design) and novelty of the approach (the novelty should be better highlighted), and discuss advantages (beyond computational efficiency) and disadvantages of the new approach in comparison to existing approaches. Else the manuscript – from my point of view -would be too close to a technical report.

Response: The main focus of this manuscript is to introduce a new approach for network design based on backward Lagrangian particle dispersions modelling and to apply this concept for designing optimal observational networks for the Australian continent. Some economic aspects are taken into account, but only for the test case. They are not part of the general concept. We will highlight this in a revised version of the manuscript and also emphasize the novelty of our approach. Further, we will include a paragraph that discusses the advantages and disadvantages of our approach in more detail.

I disagree with the first sentence of the abstract. The new approach suggests to select a priori from all possible locations of stations those, which are economically easy to realize. This is a subjective choice. This prior selection improves the computational efficiency of the network design, but by definition, the new method does not attempt to generate a – scientifically - optimal network any more. Also this method does not provide the opportunity to generate the optimal network including economic aspects, because the prior selection is subjective.

Response: The new approach does not suggest (or require) selecting possible locations of stations beforehand in general. Our approach works with both potential stations based on a gridded surface and with locations pre-selected according to certain criteria. We agree that a network designed by using possible locations of stations on a gridded surface might result in a larger reduction of the cost function, but it is up to the user to decide what kind of optimal network he wants to create and what prior information he wants to include. In this manuscript, we demonstrate the network design for Australia as a test case and here we decided to use pre-selected possible locations of stations for various reasons as stated in the manuscript. This does not mean that the resulting network is not an optimal one; it is optimal with regards to the set-up and prior information used.

We agree that the prior selection of stations is subjective in some way and we are not claiming that we performed a comprehensive economical evaluation of potential stations and their maintenance

costs, which would be beyond the scope of this paper. We merely demonstrate that it is possible to use existing infrastructure from other existing measurement sites to guarantee that the proposed location of a new station by the network design is accessible and that electricity for example is supplied. This will ultimately result in a more realistic (and cost efficient) network than by just using potential stations based on gridded surface.

We will add a statement in the manuscript to highlight that our proposed method does not require the selection of possible locations of stations a priori. In fact, the second part of this paper (Nickless et al., 2014), which focuses mainly on sensitivity analysis, demonstrates the network design for South Africa using stations only based on a gridded surface.

Given the financial costs of building and maintaining new stations, the computational costs of network design seem marginal. I would therefore suggest to consider combining the two approaches, first a general search based on a gridded surface, and on top of this the specified search accounting for the economical costs of maintaining existing or adding new towers. Only such an approach would combine the search for a scientifically optimal network and accounting for economic costs.

Response: The focus of this paper is not on setting up an optimization scheme that accounts for exact economic costs of erecting new stations or maintaining existing stations. As stated in the manuscript (page 7579) we do not have enough information with regards to actual costs in setting up equipment and maintaining a site. Costs may differ greatly between different sites and a thorough cost analysis would be required. The suggestion by the referee of doing a general search based on a gridded surface and then on top of this a specified search accounting for economical costs is an interesting approach that we might investigate in future work. However, this is beyond the scope of the current paper.

In case of the Australian example there is already information available, and the twostep approach may seem redundant. However, given Australia is only the example to introduce the new method, in general we cannot assume such rich prior experiences.

Response: In case of the Australian example we only suggest that it is more cost efficient to use existing infrastructure than setting up a new site from scratch, without quantifying actual costs. The introduced method for the network design is generic and it is up to the user on how he wants to design his own optimal network and what information he wants to include.

I don't appreciate the idea of using the measurement uncertainty as proxy for economical costs. This approach would make it impossible to account for both aspects independently and exact. As long as they are treated separately, their respective contributions to the prior and posterior cost-function could be analysed independently.

Response: We agree with the referee that it is not ideal to use the measurement uncertainty as a proxy for logistical issues. However, as discussed in the manuscript it is quite challenging to set up a cost function that includes exact actual costs which in our case are not even available.

We will revise the corresponding section in the manuscript and make it clear that one should include the actual costs if available.

I do not suggest combining the two approaches (general and selected search) or explicitly adding the economical costs in the current manuscript, but I would like to suggest addressing these aspects in more depth in the introduction and discussion. This would contribute to highlight the current paper as a relevant step towards a general approach, which objectively combines scientific improvements and economical costs.

Response: We agree with the referee, that a number of properties of the network can be optimised. We will revise the introduction and discussion section and address the combination of the two approaches as suggested.

Please explain specific terms, e.g., "surface flux" – this term is frequently used but is not explained, or "BIOS2 model runs" is mentioned in the abstract and should be explained.

Response: The term surface flux refers to the flux of carbon dioxide and comprises contributions from the biosphere and fossil fuel combustion. We will clarify this in the manuscript. BIOS2 is a modelling framework built around a land surface model. We will add this information in the abstract of the manuscript.

The analysis that shows only marginal influence of external contributions could be explained a bit

Response: The influence from outside the modelled domain and its implications on the observed concentrations and their uncertainties will be explained in more detail in a revised version. We will extend section 2.3 and clarify how we assess the contribution from the boundary concentrations on the observed concentrations. See also response to referee 2.

References:

Nickless, A., Ziehn, T., Rayner, P. J., Scholes, R. J., and Engelbrecht, F.: Greenhouse gas network design using backward Lagrangian particle dispersion modelling – Part 2: Sensitivity analyses and South African test case, Atmos. Chem. Phys. Discuss., 14, 11301-11342, doi:10.5194/acpd-14-11301-2014, 2014.