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Discussions

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**Interactive
comment**

Interactive comment on "Four dimensional variational inversion of black carbon emissions during ARACTAS-CARB with WRFDA-Chem" *by* Jonathan J. Guerrette and Daven K. Henze

Anonymous Referee #3

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The authors estimated biomass burning and anthropogenic black carbon aerosol emissions based on proven 4D-Var technique that used in the WRFDA. The authors developed the forward, adjoint, and tangent linear models to calculate innovation, gradient, and cost function. The work presented in this study is very soundful. Also, Developing adjoint model is one of the most challenge work in aerosol data assimilation especially for assimilate satellite data. The presented results shows that the method would improve the chemical inversion performance via cross validation. However, the authors need some extra analyses/explanations before publication.

(1)One major concern of the MS is that the numerical experiments were only based on two real case forecasting. Since the atmospheric chemistry and meteorological

conditions vary day to day. It is suggested that the authors extend the experiments.

(2)How many numbers of the control variables in your CHEMDA system? Only BC? Please clarify the observation Operator and its adjoint. If the control variable 'same' as observation, the observation Operator and adjoint is simply as interpolation method. If not, you should clarify in the manuscript. In addition, how to deal with cross correlation between control variables (e.g. NO3 is correlate with SO4) if the number of CV is more than two.

(3)Incremental method is commonly used method in data assimilation. The manuscript appear 'incremental' many times. I suggest delete redundant 'incremental' in the manuscript.

(4)Background error covariance (BEC) is important in data assimilation. The observation information spread to model grid cells via BEC. The authors mentioned chemical emissions heterogeneous. However, the construction of the 'B' in the manuscript seems to be homogeneous?