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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Numerical modeling of Asian dust emission and transport with adjoint inversion using LIDAR network observations" *by* K. Yumimoto et al.

Anonymous Referee #2

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This paper shows an impressive piece of work about the estimation of dust emissions over eastern Asia from ground lidar measurements. The method uses a mesoscale atmospheric model of dust chemistry-transport embedded in a variational system. A wide range of observations, from in situ to remote-sensing, are processed to evaluate the realism of the increments. Despite the overall quality of the paper, some points should be clarified, which I list hereafter.

1) The authors call their method "4D-Var" throughout the text. The term "4D-Var" was coined in the 80s in the context of NWP. At the time, it referred to the optimization of some 4D fields like temperature and humidity. As far as I understand, the authors

optimize a 3D field of emissions (2D space + 1D time), which is a major change in the concept. Another confusing aspect in the authors terminology is that NWP 4D-var systems make use of a prognostic model to compute the control variable state from one time step to the next while the authors do not. The authors should choose their words more carefully.

2) Some words are used at places in the abstract ("correctly", "sufficient", "good agreement", "agrees well", "consistent qualitatively") and in the conclusion ("good assimilation results"), that have vague meanings. The authors should be more precise about what they mean: some so-called good result today may be found poor tomorrow.

3) page 15958: The literature review misses some variational applications on real data for aerosols (Dubovik et al. 2007) and CO2 (Chevallier et al. 2005). One could also mention some theoretical studies (Baker et al. 2006, Meirink et al. 2006)

4) page 15958, line 7: it is not fair to compare operational applications with research applications

5) page 15958, line 12: 3D-Vars can adjust the sources like they adjust the concentrations but the errors are larger.

6) I do not understand Eq. (3): where has Edt gone, why do we have J in it? The equation does not seem to be correct

7) page 15960, line 11: the statement about dJ/dHC is not correct

8) page 15960, line 22: how can meteorological fields have no action on the tracer fields?

9) Eq (6) is a usual empirical assumption: referring to some paper does not help justifying it.

10) page 15964, bottom: there is a missing step in the logic: the authors also assume that air masses from different regions do not have the same potential temperature.

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11) page 4.3: given the discussed uncertainty about the CALIPSO products, what does the comparison bring to the paper?

12) section 4.4.: The assumed empirical B matrix described in section 3 may explain the location and the time-variation of the increments to a large extend: the system generates increments in the most obvious places, i.e. where the background errors are high, i.e. where the fluxes are already high. This should be highlighted given the arbitrary choice of the B matrix. Actually, this may also explain the consistency between experiments A and B (in that case, the corresponding conclusion should be changed). Sensitivity studies about the B matrix could be shown. For instance, what happens of the background term is suppressed in the cost function?

Baker, D. F., S. C. Doney et D. S. Schimel (2006), Variational data assimilation for atmospheric CO2, Tellus, 58B, 359-365.

Chevallier, F., M. Fisher, P. Peylin, S. Serrar, P. Bousquet, F.-M. Breon, A. Chedin et P. Ciais (2005), Inferring CO2 sources and sinks from satellite observations: method and application to TOVS data, J. Geophys. Res., 110, D24309, doi:10.1029/2005JD006390.

Dubovik, O., T. Lapyonok, Y. J. Kaufman, M. Chin, P. Ginoux et A. Sinyuk (2007), Retrieving global sources of aerosols from MODIS observations by inverting GOCART model, Atmos. Chem. Phys. Discuss., 7, 3629-3718.

Meirink, J. F., H. J. Eskes et A. P. H. Goede (2006), Sensitivity analysis of methane emissions derived from SCIAMACHY observations through inverse modelling, Atmos. Chem. Phys., 6, 1275-1292.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 15955, 2007.