Review of Pagowski et al.

The paper concerns an important aspect of data assimilation, namely development of techniques to assimilate aerosol data. As such it is timely and of interest to the general data assimilation community. The paper is technical, rather than scientific, and its inclusion in GMD/GMDD is warranted. The paper should be suitable for publication in GMD once the authors address the general and specific comments below.

General comments:

Introduce acronyms when first used, both in the abstract and the manuscript, e.g., PM, MODIS. The English needs improving, including avoiding repetition of text.

The paper would benefit from inclusion of references to back statements made. See specific comments.

Specific comments:

P. 2484:

L. 2: Introduce NCEP acronym - it is well known in the data assimilation community.

L. 6: Perhaps better to say: "...we present illustrative results…".

P. 2485:

L. 1-2: Many of the references cited concern tropospheric chemical data assimilation (e.g. the Elbern work). There has also been work on stratospheric chemical data assimilation, with a focus on ozone (e,g,, Geer et al., 2006). The authors should also refer to chemical data assimilation within the MACC, MACC-II projects, e.g., Massart et al. (2014).

Regarding the variational and ensemble data assimilation methods introduced, general references could be provided here. Examples include: Bouttier and Courtier, 1999; Talagrand, 2010; Kalnay, 2010.

L. 10: I suggest the authors provide references for air quality forecast systems. One example is Rouil et al. (2009) – PREV'AIR in France; the work of Elbern provides another example.

L. 16+: Indicate here what you will discuss in the paper.

P. 2486:

L. 1+: Is all this detailed information necessary?

L. 20: I suggest replacing "inaccuracy" with "error". Please specify whether this error is random or otherwise.

L. 29: Is this error the random error?

P. 2487:

L. 15: Indicate that H is a non-linear operator. Is it linearized in your system?

L. 16: R typically includes the representativeness error.

P. 2488:

L. 17: sea salt.

P. 2490:

L. 24: Define the "increment".

P. 2492:

L. 4: The subscript should be "2.5".

L. 5: Please elaborate on what you mean by "regressions", and discuss their purpose here.

L. 26: Quantify this "improvement". Significant in what sense? Statistical?

Figures:

I suggest make the figures bigger, and provide details of the colour scale range in the figure captions.

References:

Bouttier, F., and Courtier, P. (1999). *Data Assimilation Concepts and Methods*. ECMWF training notes. Available online at: http://www.ecmwf.int

Geer, A. J., Lahoz, W. A., Bekki, S., Bormann, N., Errera, Q., Eskes, H. J., et al. (2006). The ASSET intercomparison of ozone analyses: method and first results. *Atmos. Chem. Phys.* 6, 5445–5474. doi: 10.5194/acp-6- 5445-2006

Kalnay, E. (2010). "Ensemble Kalman filter: current status and potential," in *Data Assimilation: Making Sense of Observations*, eds W. A. Lahoz, B. Khattatov, and R. Ménard (Berlin: Springer), 69–92.

Massart, S., Agusti-Panareda, A., Aben, I., Butz, A., Chevallier, F., Crevosier, C., et al. (2014). Assimilation of stratospheric methane products in the MACC-II system: from SCIAMACHY to TANSO and IASI. *Atmos. Chem. Phys.*. 14, accepted.

Rouïl, L., Honoré, C., Vautard, R., Beekmann, M., Bessagnet, B., Malherbe, L., et al. (2009). PREV'AIR: an operational forecasting and mapping system for air quality in Europe. *Bull. Am. Meteorol. Soc.* 90, 73–83. doi: 10.1175/2008BAMS2390.1

Talagrand, O. (2010). "Variational assimilation," in *Data Assimilation: Making Sense of Observations*, eds W. A. Lahoz, B. Khattatov, and R. Ménard (Berlin: Springer), 40–67.