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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Development and application of the WRFDA-Chem 3DVAR system: aiming to improve air quality forecast and diagnose model deficiencies" *by* Wei Sun et al.

Anonymous Referee #1

Received and published: 23 March 2020

This is a manuscript describing a WRFDA-Chem system with data assimilation adjustment for its initial condition and shows that data assimilation improves the predictions particularly when aerosol and gas observations were simultaneously used. The results show improvements in chemical DA skills. The study is important for the use of major pollutant observations is well written, and is in the scope of the journal. I recommend publication after some additions related to background error covariance (BEC) to get a more complete picture of the method presented.

One additional analysis that I would like to see is a comparison among BECs per species. This would help show how each BEC constrains the spreads vertically and

horizontally around the observation sites. Similar analyses are described in below:

Descombes, G., Auligné, T., Vandenberghe, F., Barker, D. M. and Barré, J.: Generalized background error covariance matrix model (GEN_BE v2.0), Geosci. Model Dev., 8(3), 669–696, doi:10.5194/gmd-8-669-2015, 2015.

Liu, Z., Liu, Q., Lin, H.-C., Schwartz, C. S., Lee, Y.-H. and Wang, T.: Three-dimensional variational assimilation of MODIS aerosol optical depth: Implementation and application to a dust storm over East Asia: AOD DATA ASSIMILATION, Journal of Geophysical Research: Atmospheres, 116(D23), doi:10.1029/2011JD016159, 2011.

Other minor issues:

1. Please present other emissions such as dust, biogenic and fire emission used in your study.

2. Please describe the reason why cross correlations were not applied.

3. Could you describe the other trials for the background error covariance of the PM-coarse? Did the inflation factor of 90 was applied along with all vertical levels?

Specific: Please use the same terms (gas phase or gas-phase)

Page 1. line 20: SO2 and CO -> SO2, and CO

Page 3. line 42: fastest growing -> fastest-growing

Page 3. line 43 : extreme haze -> the extreme haze

Page 4. line 58: scientific community -> the scientific community

Page 5. line 87: treatment -> treatments

Page 6. line 102: data assimilation -> DA

Page 6. line 108: recent -> recently

Page 6. line 113: extend -> extent or extends?

Page 6. line 116: observations and -> observations, and

Page 7. line 123: brief summary -> summary (tautology)

Page 8. line 151: capability -> the capability

Page 10. line 197: PM25 are -> PM25 is

Page 11. line 205: in first -> in the first

Page 12. line 233: each of the aerosol/chemical variable -> each of the aerosol/chemical variables

Page 13. line 253 – 256: needed to be tailored more clearly

Page 15. Line 295: is slightly larger -> are slightly larger

Page 16. line 303: Due to lack -> Due to the lack

Page 16. line 305: As show -> As shown

Page 16. line 308: among -> to

Page 16. line 316: including bias, RMSE and correlation -> including bias, RMSE, and correlation

Page 16. line 318: model -> the model, poor -> poorly

Page 17. line 322: percentage -> percentages

Page 17. line 328: lead -> leads

Page 17. line 329: individual -> the individual

Page 17. line 330: general -> generally

Page 18. line 346: applications, but also -> applications but also

Page 18. line 362, Page 19. Line 364, and Page 21. Line 425: heavy -> heavily

Page 19. line 379: ALL_3h and ALL_1h -> ALL_3h, and ALL_1h

Page 20. line 397: becomes -> become

Page 20. line 403: determine -> determines

Page 21. line 411: SO2 and CO -> SO2, and CO

Page 25. line 508: study -> a study

Page 25. line 509: contains -> contain

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