

Interactive comment on “Assimilation of satellite NO₂ observations at high spatial resolution” by Xueling Liu et al.

Anonymous Referee #2

Received and published: 17 October 2016

General comments:

The focus of this paper is to test the ability of estimating emissions of NO₂ with data assimilation and future high resolution satellite instruments by doing an Observing System Simulation Experiment (OSSE), since the temporal and spatial variability of NO₂ are high and hourly observations at a resolution of at least 5km would be required. I think the title should include “using OSSEs”, otherwise it suggests that real data experiments have been carried out.

The abstract and the introductory section are excellent. One of the main experimental conclusions is that the assimilation of meteorology and of NO₂ should be done simultaneously, supporting Kang et al. (2012) who pointed out the need to do simultaneous assimilation of the meteorology and atmospheric CO₂ and thus succeeded

C1

(in an OSSE framework) in estimating accurately the surface carbon fluxes even in the absence of any a priori information.

Sections 2-4 are not written clearly enough, in my opinion, at least not for a person who is not very familiar with the details of the subject, like this reviewer. In addition, much of the results revolve around an unrealistic experiment: having the TEMPO NO₂ observations at very high spatial and temporal resolution, and at the same time assimilating the winds every 12hr or even 24hr, which, not surprisingly, ruins the results. I would suggest to replace this with a more realistic experiment: Assume that you have access to a meteorology data assimilation performed every hour, so that you have access to the mean winds but not to the uncertainties. Are the wind uncertainties essential? Experiments that we have performed suggest that the wind uncertainties are not so important for CO₂, but they may be for NO₂ because of the smaller scales involved.

My recommendation is that this paper is important and could be accepted after major revision. Detailed comments:

P3, line 28: “After a spin-up time of 40 hours on the outer domain, the inner domain simulation is initialized and constrained through one-way nesting in both meteorology and chemistry”. It is not clear whether this is in addition of the data assimilation, and for how long it is done.

P4 line 1: “We use the RADM2 gas phase chemical mechanism for its simplicity (Stockwell et al., 1990)” I don’t know what this means.

Line 12: Since Kang et al. (2011, 2012) were the first to estimate surface fluxes of carbon as evolving parameters, perhaps they should be referenced.

Line 19-24. This is an interesting persistence approach to estimate the emission forecast model. I am not sure whether it will always work in the presence of error spin down or if the surface fluxes vary substantially. It would be good to show how well it works in this case, perhaps under varying surface fluxes.

C2

P5 line 6: “showed” not “suggest”

Lines 13-14: Are these simulated observations obtained from NARR?

Line 24: Does you model changes in the “truth” in the simulated TEMPO observations or are the fluxes fixed?

P6 line 10: It would be good to show a companion figure showing the diurnal cycle.

Line 14 “a mean uncertainty of 7%, which is lower than the 35%...” unclear.

Line 19: AMF: I couldn't find its definition. In general there is a profusion of use of abbreviations whose original definition is difficult to find in the paper. I can deal with Control run (CR) and Nature Run (NR) but then new capitals appear (AR) defined somewhere else, and I get confused. If all the acronyms were defined in the same place it would be OK, but my pdf reader, when I search for the definition of AR, gives me hundreds of words that contain “ar”.

P7 line 24: “the 17:00LT assimilation cycle each day” suggests that the assimilation may have been done for many days, and I really don't know yet whether this is true, or just one day was simulated (with constant true emission?).

Along these lines, it would be really strange for a real life researcher to use detailed TEMPO observations every hour and then do atmospheric assimilation only every 12 or even 24 hours. The experiments ENS-O and ENS-T are not realistic (and have horrible acronyms). I would drop these experiments. The results shown in Figure 3 are very obvious: when you assimilate wind observations the uncertainty in the winds becomes much smaller, and the transport errors likewise.

P8 line 7 The acronym of “No meteorological observations assimilated” should NOT be called “BIAS-MET”, the errors are much more than a bias!

Fig 3: Label “Local time (hours)”

Fig 4: Labels: “Longitude” “Latitude” in the figure, not in the figure caption.

C3

Fig 5: It confirms that not assimilating the atmospheric winds results in huge errors, as expected.

Fig 6: BIAS-MET is yellow?

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-770, 2016.

C4