

## **Review of Singh et al., revised manuscript (acp-2011-473-manuscript-version3.pdf)**

I acknowledge the updates done in the revised manuscript. Unfortunately, it reveals the shortcoming already noted in my first review. Although I gave several directions to improve the paper, many of them have not been followed. In its current form, I found the paper far from being satisfactory for ACP. Below are the reasons that justify such a decision.

### **Spinup**

The comparisons between the different assimilation experiments should exclude the spinup period. By keeping the spinup, the Sect. 6.2 is very confusing because it is never clear if the differences between the experiments are due to the spinup or to the experimental setup. Thus, a proper comparison between the different experiments (and methods) is not possible.

### **Period of Evaluation**

From a statistical point of view, the period of evaluation is also too short to provide a fair picture of the performance of the different experiments (and methods). At least two months of assimilation should be considered (excluding the spinup period). Consequently, the assimilation experiments have to be rerun starting in mid-July and ending (at least) on September 31, 2006. The spinup period should also be identified and excluded from the discussion. If the authors want to discuss the spinup period, a separate section should be devoted to this issue.

### **Region of Evaluation**

If the authors only focus on the North America, it should be mention in the title and they should not show results outside this region. However, the paper might be better if it also considers other regions than North America, as in Geer et al (2006). This would probably require the authors to find other ozone independent dataset than those obtained during the INTEX IONS-6 campaign. In their reply, the authors say : *"Our comparison is exactly similar to the well accepted article by Parrington et al. (2008) which is specifically for North America."* I remind that Parrington et al. did not pretend to compare the three assimilation before-mentioned as it is the goal of the present study. Parrington et al. only pretended to study ozone over North America.

### **4D-Var Assimilation Windows**

The assimilation windows used for the 4D-Var experiments are also very long. This was already pointed out in my previous review and addressed by the

authors in their responses. However, I disagree with their responses (here below in italic) for the following reasons:

*1-day assimilation window length is typical for regional models such as CMAQ, however, for global models like GEOS-Chem, window length of several days is suitable to capture all the physical and chemical dynamics.*

**Answer:** True, but it does not mean that the 1-day assimilation window is not good. Moreover, as far as I know, 4D-Var assimilation experiments with such long assimilation windows are not common. So, if the assimilation window needs to be longer than 1 day, it must be demonstrated.

longer assimilation window than 1 day is necessary, it must be demonstrated.

*The Aura satellite covers the whole globe in two weeks. Therefore, the two weeks assimilation window was chosen to use maximum observation data. Window length of 5 days was chosen to see how the generated analysis varies by changing assimilation window lengths.*

**Answer:** This is not a valid answer. Many 4D-Var systems assimilate observations which do not provide a global coverage, e.g. at ECMWF with a 6 hour assimilation window.

*Our global model includes stratospheric-tropospheric ozone exchanges through LINOZ chemistry routine which injects ozone from stratosphere into the troposphere. Since ozone lifetimes in stratosphere are longer than several days, it was important to perform longer assimilations.*

**Answer:** Do you mean that the assimilation window must be of the same length than the lifetime of the assimilated species? As far as I know, the assimilation of CO (lifetime of 2-3 months) is always done using assimilation window much shorter than that. Again, this is not a valid answer.

I would also like to clarify the terminology of "assimilation window" which seems to be wrongly used in the paper. The assimilation window is defined by the time window in which observations are used to optimize the initial conditions. In the 3D-Var and KF experiments described in the paper, the assimilation window is 4 hours. On the other hand, the two 4D-Var experiments are performed with two different assimilation windows, respectively, 5 days and 2 weeks. In place of "assimilation windows" (e.g. L265 and L511), I would rather talk about the "assimilation periods" or "experiment periods".