Answers to Meiyun Lin

Introduction and literature review:

There are studies showing that high-resolution chemistry-climate models with interactive stratospheric and tropospheric chemistry capture the observed layered structure (stratification) of ozone vertical profiles in the free troposphere and at the interface with the PBL. For example, see Figures 3, 5 and 7 in Lin et al. (2012) and Supplementary.

Figures 1 and 2 in Lin et al. (2015). Lin, Meiyun, A. M. Fiore , O. R. Cooper , L. W. Horowitz , A. O. Langford , Hiram Levy II , B. J. Johnson , V. Naik , S. J. Oltmans , C. Senff (2012): Springtime high surface ozone events over the western United States: Quantifying the role of stratospheric intrusions, Journal of Geophysical Research, 117, D00V22, doi:10.1029/2012JD018151

Lin, Meiyun, A.M. Fiore, L.W. Horowitz, A.O. Langford, S. J. Oltmans, D. Tarasick, H.E. Reider (2015): Climate variability modulates western US ozone air quality in spring via deep stratospheric intrusions, Nature Communications, 6, 7105, doi:10.1038/ncomms8105.

We thank Meiyun Lin for these additional references. Indeed these two studies show that the GFDL AM3 model captures reasonably well the vertical structure of O_3 profiles. However, to our opinion, the time and space coverage of these specific studies remain too limited to get firm conclusions on the model ability to reproduce the O_3 vertical gradients in the lower troposphere. But we agree that a good representation of the chemistry combined with a high spatial resolution is very useful to get closer to the observed profiles of O_3 mixing ratios. We included these two references in the manuscript, and modified the paragraph page 2 lines 15-21 as followed : “Over the last decades, a continuous effort was put to collect in-situ observations in the troposphere, mainly with commercial/research aircraft and sondes, and to a lesser extent with instrumented mats and tethered balloons. However, the amount of in-situ data available in altitude remains relatively low compared to the surface (both in terms of quantity of data and number of species). In particular, profiles throughout the entire PBL (i.e. starting from the surface and extending to the free troposphere) are relatively sparse. This limits our ability to properly describe and understand how pollution is vertically distributed within the PBL. One consequence is the difficulty of many state-of-the-art models to reproduce accurately the vertical stratification of the pollution in this part of the troposphere. Although some high-resolution chemistry-climate models (CCMs) with interactive stratospheric and tropospheric chemistry can show encouraging results at the episodic scale (e.g., Lin et al., 2012, 2015), several initiatives of models inter-comparison depicted substantial errors on the ozone (O_3) and carbon monoxide (CO) vertical distribution over longer periods of time (Elguindi et al., 2010; Solazzo et al., 2013). More recently, Travis et al. (2017) highlighted the difficulty of the GEOS-Chem chemistry-transport models (CTM) to reproduce sharp O_3 vertical gradients in the first kilometre above surface of the Southeast United-States (during both clear-sky and low-cloud conditions), attributed to excessive top-down mixing in the model.”