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Interactive comment on "Air-quality in the mid-21st century for the city of Paris under two climate scenarios; from regional to local scale" *by* K. Markakis et al.

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The typical nesting used for WRF (and for CTM modelling) is a factor of 3 with consistent grid scales for both the meteorology and chemical modelling, but in this study, the meteorology is nested from 50 km to 10 km, while the CTM results are nested from 50 km to 4 km. The authors should address first how and why the meteorology is nested to 10 km while the chemistry is nested to 4 km and what are the effects of these differences. Our reasoning behind our decision to stay at 10km resolution was based on work done with the same model (CHIMERE) in France. First the authors acknowledge the fact that a refined meteorological resolution can impact the quality of

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the simulations, but given the fact that Paris is characterized by a rather flat topography, away from the ocean, higher resolution meteorology is not expected to improve the results of the air-quality modelling at 4km. More specifically, Menut et al. (2005) showed that apart from coastal areas where refined meteorology improved air-quality modelling results, in the rest of France ozone peaks were better captured with lower resolution meteorological input. Valari and Menut (2008) showed that a refined meteorological input gives similar results for ozone and that model performance is much more sensitive to the resolution of emissions than to meteorology. This discussion as regards WRF is incorporated in the manuscript. From the WRF official website (http://www.mmm.ucar.edu/wrf/users/docs/user_guide/users_guide_chap5.html#_e._One-way_Nested) we quote: "when one-way nesting is used, the coarse-to-fine grid ratio is only restricted to be an integer. An integer less than or equal to 5 is recommended". Second, are there any specific issues associated with larger than normal nesting steps?

Reply: The main focus of the paper is the response of the model to the emission changes at local scale. We believe that the emissions strength reductions in the future are sufficiently large to outbalance any difference that would be caused by more "reliable" boundaries provided by an intermediate domain. The nesting step from 30km or 50km to a few km of resolution in the local scale is commonly used with CHIMERE (Vautard et al., 2001; Beekman and Derognat, 2003; Vautard et al., 2007; Deguillaume et al., 2008; Valari and Menut, 2008; Valari et al., 2011). In any case in the sensitivity analysis of chemical regimes we show that local emissions is a key factor to the observed change of the regime and can explain the response of the area to the future emissions reductions. Apart from some influence in the rural stations that are closer to the boundaries we do not consider that an intermediate step in the CTM would produce something significantly different in the high-titrating areas.

An important aspect of climate impacts on air quality is the role of biogenic emissions sensitive to temperature and other meteorological factors. There is no description of

how biogenic emissions were treated and whether the biogenic emissions played any significant role in the modelled changes.

Reply: CHIMERE uses an on-line coupling of the MEGAN version 2.04 model to calculate biogenic emissions. Unfortunately we cannot quantify to what extend biogenic emissions influence the observed differences. A brief discussion on qualitative basis is located on page 108, line 19 concerning the REF scenario: "Consequently, enhanced ozone formation is expected especially in the rural part of the domain due to increase of biogenic organic compounds (BVOCs). Monoterpenes are especially sensitive to temperature while isoprene to both temperature and sunlight. We do not observe any significant changes to short-wave radiation, RH or precipitation under the REF scenario" and on page 109, line 6 for the MIT scenario: "Lower temperatures are expected to inhibit ozone formation while the drop of shortwave downward radiation by 16.6% relative to present will lead to less BVOCs in the rural areas."

Because a major focus in this paper is on how emissions changes affect ozone chemistry, there should be a better documentation of the changes in emission among the control and two future projection cases. A table or graphic summarizing regional and/or urban emissions (NOX, VOCs, etc) for each case would be helpful.

Reply: Emission reductions for present time and the two scenarios are provided in Table 1 for NOx, VOCs and fine particles for the local scale inventory. However, we avoided deliberately presenting any direct comparison between the local scale inventory and the GEA regional scale inventory since emission totals do not match between the two cases and such a comparison would be misleading. We believe that it is sufficient to show that air-quality projections modelled at different scales and therefore under different chemical conditions are significantly different.

The authors note that peak ozone episodes are not fully captured by the modelling system as evident from the current decade evaluation results. How does this aspect of model performance affect their overall conclusions related to future ozone behaviour?

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In this case, do the results represent a lower bound on future ozone levels?

Reply: We believe that failing to capture episodic ozone peaks has a negligible impact on our overall conclusion because the number of episodes in the simulated decade is too small. The underestimation of the daily maximum ozone is only ∼7% in our simulation which is rather low to let us assume that future trends represent a lower bound on future ozone, especially considering that average present-time daytime values almost unbiased.

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