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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of Urbanization on Regional Meteorology and Air Quality in Southern California" *by* Yun Li et al.

Anonymous Referee #3

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This manuscript investigates impacts of urbanization in Southern California on regional meteorology and air quality. Simulations using an innermost domain with 2 km resolution are conducted by WRF-Chem coupled with UCM. The simulations are driven by current climate and anthropogenic emissions with and without urban pixels and are applied to characterize impacts of historical urbanization on regional and temporal distributions of temperature and concentrations of NOx, O3, and PM2.5. The authors conclude that urbanization causes daytime decreases in temperature and increases in O3 and PM2.5. In the nighttime, the simulation results present nighttime increases in temperature and O3, while the concentrations of NOx and PM2.5 show reductions. The authors attribute these changes to urban-induced modifications in various competing drivers including irrigation, thermal properties of building materials and surface

roughness.

General comments:

The topic addressed is interesting and relevant to ACP readers. However, I have reservations about the robustness of the conclusions presented. In my opinion, significant revisions with new analysis and more careful model verification of the simulations are required.

The impact of urbanization is derived from the differences between temperature and concentrations of fields simulated by a WRF-Chem configuration that includes urban pixels and by a scenario where urban pixels were converted to shrub. This methodology has been presented in previous work and the nighttime impact of urbanization has been well documented in the literature. For instance, the paper by Li et al ("Achieving accurate simulations of urban impacts on ozone at high resolution", ERL, 9, 2014) introduced similar configurations (WRF-Chem including anthropogenic emissions, with and without urbanization) and used them to derive impacts of urbanization on air quality by analyzing the differences in the simulated fields between the two scenarios. Although the region and the period of time considered in this manuscript are different, the main idea and the nighttime impact are similar. The daytime impact reported in this manuscript is questionable because its magnitude shows values smaller than the model error (see specific comment 2). Careful analysis of the robustness of the impact is needed, especially given that this impact conflicts with previous results as reported (Line 355). The authors need to emphasize what is new related to this research and how it advances the existing research on the topic.

Specific comments:

1-It is unclear why the authors chose a 10-day period of the summer of 2012? And in what basis the period chosen is "representative of typical summer days in Southern California"? Why not using more years?

2-The statistics presented in Table 1 indicate that the impact of urbanization is smaller than the model error for all the fields analyzed. For example, the magnitude of the simulated change in O3 is less than 5.6 ppb (Line 429). The mean and root mean square errors reported in Table 1 are 11.8 ppb and 14.6 ppb, respectively. Thus, the impact described, which is the main conclusion of the manuscript, is not robust given that it lies within the model error. Perhaps, simulations using other years could increase the statistical significance of the results presented.

3-The authors state in the conclusion that "…due to historical urbanization are the main drivers of regional meteorology and air quality changes in Southern California" (Line 567). However, the simulations presented in the manuscript cannot be applied to reach such conclusion. There are several critical factors that are not accounted for. For example, the initial and boundary conditions use current atmospheric conditions and therefore do not include the effect of climate change. The amount of the background CO2 concentration specified in WRF is fixed (assuming that both configurations use the same setup except for urbanization as stated). The anthropogenic emissions did not exist before human settlement. I suggest that the authors rephrase their motivation and conclusion, and simply focus on the impact of urbanization without attributing historical changes solely to urbanization.

4-There are some claims that need clarification. For example the authors state in line 152 "In this study, we couple WRF/Chem to the urban canopy model (UCM)…" However, the WRF/Chem model is already coupled to UCM. I believe what the authors did is activating the option for this coupling. In line 180 "we update the default WRF/Chem to include a real-world representation of land surface physical properties and processes…" But again, the options for using NLCD and NUDAPT for land surface representations are available within WRF. Please clarify what is meant by "we update the default WRF/Chem".

5-The ability of WRF-Chem to realistically represent urban processes requires more evaluation to better establish the credibility of the present-day scenario. The compari-

son between observations and simulations shown in Fig. 3 does not indicate to me a "good fit at lower values" as stated in line 294. The observed low values of temperature are around 290 K, but the simulated temperature shows low values of 287K. The difference between these values is larger that the impact reported. Therefore, better model verification should be considered. I also suggest adding to Fig. 3 panels comparing diurnal variations of observed and simulated temperature, O3 and PM2.5 (similar to Fig. 4a).

6- Figs 5, 7 and 9 include values of simulated fields within urban grid cells only. The authors should consider superimposing in these figures values for the entire domain including nonurban grid cells. It would be very helpful to see the differences in the simulated fields within both urbanized pixels and also grid cells that remain natural in both scenarios considered.

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