Referee report: „On the spatio-temporal representativeness of observations“, by Nick Schutgens et al.

General comments

In this study the authors analyze the spatio-temporal representation errors of aerosol data for a variety of observation methods (incl. ground-based and remote sensing) using high resolution model data. This analysis is important and relevant because long-term climate studies and model evaluation rely on the use of L3 data in which the construction of the L3 data may be significantly impacted by the discontinuous spatio-temporal sampling of the observations. However, some of the findings have been presented already in the previous papers S16a and S16b. The paper is written in a clear and concise manner. I recommend publication after minor revisions.

Minor / Specific comments

Introduction: I would suggest to add a reference related to representation errors in ozone observations, e.g., Sofieva, V. F., Kalakoski, N., Päivärinta, S.-M., Tamminen, J., Laine, M., and Froidevaux, L.: On sampling uncertainty of satellite ozone profile measurements, Atmos. Meas. Tech., 7, 1891-1900, doi:10.5194/amt-7-1891-2014, 2014.

Page 3, Section 2.1: Please explain N10/N50 and introduce “BC” as abbreviation for black carbon (used later on in the paper).

Sections 3.2 - 3.5: I would suggest to merge the description of the different figures into one subsection.

Page 8, lines 9/10: Why is clear sky day-light AOT lower than average AOT?

Page 11, Sec. 6.2: Are the numbers the errors due to “purely spatial sampling”?

Page 14, Sec. 9.3: Please add a comment here that you find similar results for polar orbiting satellites and geostationary satellites. At least for me this was a bit surprising as I expected lower errors for the geostationary satellite observations due to multiple views per day (instead of one measurement per day for the LEO).

Page 15, line 30: Not sure whether I can follow conclusion 3). Could you please add an explanation here. Like referee #1 (her/his comment no. 18) I think that estimates of the monthly mean will improve with increasing number of observations.

Page 16, lines 7/8: You say that the results were robust across the regions, but what about the selected months? Did you analyze the natural variability of the observables as a function of month? Do you think that the selected months are representative for the whole year / other years? Errors may increase/decrease significantly if natural variability is different for different months.

Fig. 2: I find it difficult to identify the blue line. Is it possible to show only one red line (e.g., mean/median + std.dev. of all observations 2000-2010)?

Technical corrections

Page 22, Fig. 5, caption: “210 x 210 km” -> “210 x 210 km^2”

Page 25, Fig. 9, title: “obs: 210 x 10 km^2” -> “obs: 10 x 10 km^2”

Page 31, Fig. 16, title: “obs: 10 x 210 km^2” -> “obs: 210 x 210 km^2”

Page 34, Fig. 20, caption: “PM25” -> “PM2.5” and “km” -> “km^2”

Page 35, Fig. 21, caption: “PM25” -> “PM2.5” and “km” -> “km^2”

Page 36, Fig. 23, caption: “km” -> “km^2”

Page 37, Fig. 24, caption: “km” -> “km^2”