Answer to referee 1

December 20, 2013

We would like to thank referee 1 for the review, particularly for the advice on the analysed cases and suggestions for enhancing the studies with amplitude maps.

In the following we would like to answer to the individual points .

Major issues

Point A:
We would like to thank the reviewer for this insight in the modeller community's requirements. We chose regions not too small because the time frame of the analysed data is rather short (just the year 2009), so at least the regions should have a minimal size in order to have enough data points. However, we distinguished between land and water pixels for the northern hemisphere (where the viewing zenith angle < 72 degrees), but not specifically for Central Europe. Following you suggestion, we analysed the approximate region of central Europe (to be more precise the part of the SEVIRI disc between 6.0 and 23.5 degrees longitude and 45 and 54 degrees latitude. For the summer month convective processes can be observed, the liquid water path increases during daytime for middle level clouds and for high opaque clouds, see figure 1 below. Unfortunately the comparison for the winter is hampered by the restriction of the solar zenith angle that has to be smaller than 72 degrees. So there are just 5 illuminated hours in that region which is not enough for a diurnal cycle in our opinion, see 2. Also to demonstrate the transition from stratiform to convective cloud formation in Central Europe, the glaciation of clouds would have to be included in the analysis. This would require an extensive reprocessing of the available data and is, in fact, beyond the scope of this manuscript. Therefore we postpone this analysis to later studies.

Point B:
First: Our objective was to give statistics of the cloud types as they are seen by SEVIRI in its field of view, therefore the complete field of view has to be considered. To give a more detailed insight, we constrained our analysis to specific cases, for example the cloud deck off the coast of Namibia and Angola

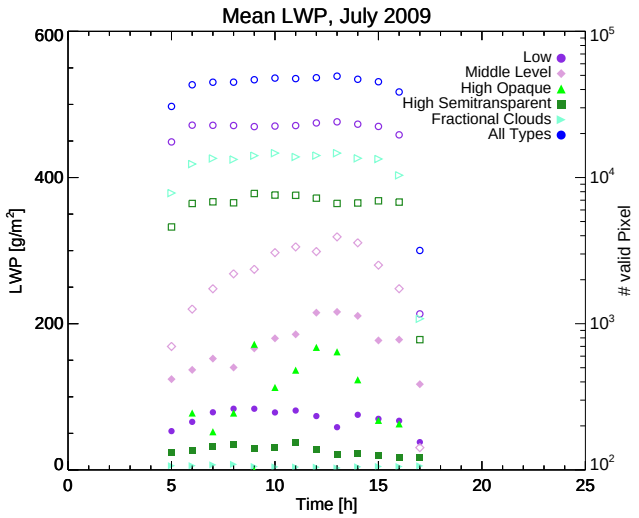

Figure 1: Average diurnal cycle of LWP for distinct cloud types (closed symbols) and the corresponding number of occurrence (open symbols) July 2009. Level 2 data from Central Europe were considered, cloud-free pixels were not included in the average, i.e. variations in the average are caused by intrinsic LWP variability.

where mainly low clouds are present and the meteorological influences on cloud development are manageable.

Second: In the figures, the diurnal cycles are presented in local time, since different regions of the earth are shown, the illuminated hours change from picture to picture. For the average values we only take illuminated pixel into account.

Third: It is true that for larger domains the length of the diurnal cycles from individual pixels is not equal due to the varying illumination times. Some information is unfortunately lost in this way, but on the other hand we analysed large areas to have enough pixel so that the overall statistics stay constant with time (please compare section 3.1). We included a discussion in section 3.2, second paragraph.

Fourth: Thank you very much for this advice, even though it is not so easy to show global maps due to the varying illumination conditions. We included an analysis in section 3.2

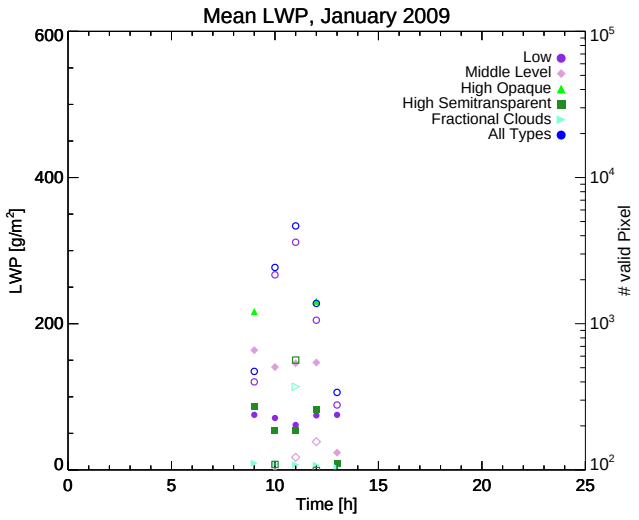

Figure 2: Same as above but January 2009.

Point C:
We would like thank the reviewer for this discussion point and clarify our approach. Please be aware that we do not study individual clouds and their development. In order to give a complete development cycle, the inclusion of ice phase would be needed and the analysis would have to be changed to individual case studies. Opposed to this, we consider the overall statistics of the cloud types. So the diurnal cycle of LWP for a specific cloud type (not a specific cloud) has a special form in a special region. This is what we can say from SEVIRI data. The form of the curve is determined by several factors: first, there are the meteorological conditions, e.g. convection of land-sea-breeze, second there are other influences that determine the form of the curve like the transition from one cloud type to another (e.g.through convection) or the transition from liquid to ice phase. All those influences cannot be entangled in the overall statistics that we present in this paper and this is also not what we intended to do. So we did not correct for the cloud phase cycle, but described the approach more detailed in section 3 and in the conclusion. Still we tried to choose regions, where some effects could be excluded, e.g. the Angola/Namibia low cloud deck was picked because the probability for ice phase in these clouds is very low (which helped to compare with the microwave statistics).

Point D:
We improved figure captions and the figures themselves. Figure 4 shows the

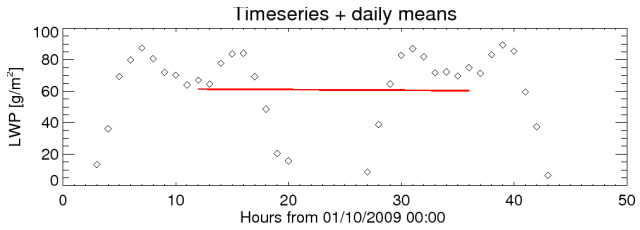

Figure 3: Zoom into the first 2 days of the figure 4 of the article: time series of LWP for low clouds in Europe, 10/2009, diamonds depict spatial averages for Europe of the individual time slots, i.e. one diamond per hour, the red line shows the daily averages of the respective data points.

spatial average LWP for the European region slotwise, i.e. one diamond corresponds to one point in time or one symbol per hour, respectively. The clusters appear due to the gaps in the time-series. The time axis is equally spaced, but since LWP is a daylight-only variable, gaps occur during night-time. A zoom into the first two days is shown in figure 3 below. The red line shows the daily averages of the same data.

Minor issues Section 3 Analysis: Daylight cycle: We added the following explanation:
"The local time of the individual data points was taken into account by sorting the pixels into time zones. In figure 6 the results for October 2009 are displayed; it should be noted that the algorithm yields results during daylight only, i.e. where the solar zenith angle and the viewing angle of SEVIRI are smaller than 72 degrees. Additionally, the average diurnal cycles are only displayed, when the number of observations for the individual hours was not smaller then 1 % of the average number of observations. We also considered only the hour for which the retrieval was made, not the minutes, so 11:45 a.m. at 0 degrees longitude would be sorted into 11:00 a.m. for example, which leads to a slightly asymmetric curves."

The remaining points are accepted and changed at the indicated positions.