Interactive comment on “Microphysical properties and high ice water content in continental and oceanic Mescoscale Convective Systems and potential implications for commercial aircraft at flight altitude” by J-F Gayet et al.

Reply to Reviewer # 2

We thank the reviewer for his detailed review and valuable comments. The manuscript has been modified according to the suggestions proposed by the reviewer. The remainder is devoted to the specific response item-by-item of the reviewer’s comments :

1. I am somewhat concerned about the use of the data from the 2007 continental convection study, much of this has already been published by these authors and I would reduce this to a summary. I do see the value in using this for comparison with the MCS.

The combined observations from the 2007 continental convection study have been analysed with details in Gayet et al. (ACP, 2012). During this study the aircraft flight plans were carefully designed in order to quasi simultaneously observe the same convective cloud from both in situ measurements and airborne and satellite remote sensing data. This data set is unique because it describes the core of the cell where unusual microphysical properties are evidenced. This feature allows for the first time to explain the backscatter anomalies reported by Platt et al. (2011) and was not thoroughly discussed in the Gayet et al. (2012) paper. This is the first result of the present paper and therefore we kept a detailed description of the 2007 results for clarity reasons.

2. The differences between the MCS and continental cloud are quite significant and for this reason I am not convinced about the validity of comparing the in situ microphysics observed from the aircraft study in the continental convection with the MCS satellite retrievals. This section either needs to be removed or the justification for comparing the microphysics from in situ measurements with remote sensing data from a completely different cloud needs to be made much clearer. There are a number of issues here: a. The input aerosols are likely to be very different for the continental and marine cases and hence the numbers and sizes of water droplets and ice crystals are likely to be very different. b. The generation of chain aggregates in the highly charged continental cloud is a process likely to be much reduced in the marine cloud c. The trajectories of particles within the MCS are likely to be very different to the continental cloud and hence the size distribution of particles arriving at cloud top is also likely to be very different. d. The possible under sizing of particles due to inlet fracturing is raised. Despite the lack of anti shattering tips this can be investigated using arrival time analysis, however, these problems are especially acute using an FSSP.

The reviewer is right, the differences between the MCS and continental cloud are quite significant via different aerosol inputs and dynamical properties (weaker updrafts in maritime MCS, Mason et al., 2006). Therefore differences should be expected on bulk parameter relationships. Nevertheless, analysing various cloud types and geographical regions, Matrosov and Heymsfield (MH, 2008) concluded that the derived IWC-Z relations are likely to be applicable to a wide variety of precipitating cloud systems. This important result makes very interesting to superimpose on the MCS IWC-Z scatterplot the relationships obtained from in situ observations related to the continental convective cloud (26 May 2007). Therefore Section 5.1 (Ice water content) has been re-written accordingly with the issues pointed out by the reviewer about aerosol inputs, dynamical properties and in situ measurement shortcomings (see revised version of the manuscript). It is found that the relationships obtained from in situ observations related to the outflow cirrus observations (2007), fit roughly with the retrieved IWC-Z relationships (C2B and DAR) This is a consistent feature since the retrieving techniques use forward model assumptions mainly based on experimental results obtained in anvils and/or outflow cirrus. On the contrary, for the core of the convective cell the IWC-Z relationship would produce much larger IWCs by about one order of magnitude than the more standard relationships. This feature is discussed in the revised manuscript via the unusual particle shape of numerous small ice crystals, the significant shortcomings which occur on IWC and Z derivations from in situ measurements and the systematic errors on in situ measurements due to the contamination by the shattering of larger ice crystals on the probe tips

3. On P2552 the liquid water and ice water contents retrieved are compared to adiabatic liquid water contents from cloud base. A factor of 2 reductions in Ice water content compared to adiabatic is possibly attributed to dry air entrainment. Another factor not mentioned is that precipitation will remove water. Is it possible to make an estimate of this ?

The authors agree with the reviewer. The process of precipitation removing water has been added inn the revised manuscript. It seems very difficult to estimate the efficiency of this process. Only microphysical cloud modelling could help in this way assuming the knowledge of dynamical convective field and microphysical properties of precipitating particles (mass – fall speed relationships which are strongly dependent on particle shape).