Manuscript Title: *Genesis of Diamond Dust and Thick Cloud Episodes observed above Dome C, Antarctica* **by Ricaud et al.**

Revised title: *Genesis of Diamond Dust, Ice Fog and Thick Cloud Episodes observed and modelled above Dome C, Antarctica*

RESPONSES TO THE REVIEWERS

We would like to thank the reviewers for their insightful comments that were helpful in improving substantially the presentation and contents of the revised manuscript. We have addressed appropriately all issues raised by the reviewers. The reviewers' comments are repeated below in blue and our responses appear in black.

We have modified this sentence in the acknowledgments:

> We finally would like to thank the three anonymous reviewers to their fruitful comments.

Changes have been highlighted in yellow in the revised manuscript.

Anonymous Referee #1

REV 1

Title: Genesis of diamond dust, ice fog, and thick cloud……..

Submitted by Ricaud et al

Date Feb 14 2017

Decision: Rejection/Resubmit

General Comments:

I am still not happy with content of this work, it is not much improved. I feel authors should focus on what they like to show and they should stick with their goals. Even the objectives are not clear in this work, and figures are not represented properly. Organizing of the text is also poor. How can someone use the results of this work for studying Arctic clouds/fog? I will not go details here but important issues are provided below randomly.

Issues:

1) Genesis means what? Even they do not summarize the cases properly and talking about genesis????; what these numbers mean? Abstract is too long. Look at page 7; LN131-136; I see they are not focused and clear. LN132 episode 1 talks about DD, IF episodes, and LN135-136 genesis of DD, IF, Thick cloud…….

These clearly show this paper doesn't analyze the cases properly, and objectives are not given in the end of introduction but in the middle of the text (page 6). This is very awkward writing style.

→ We thank the referee for the time to review the manuscript. The main concern of the referee relates to the organization and writing style of the manuscript. However, two out of three referees have no issue with the manuscript in its current form. We therefore prefer to keep the organization of the manuscript as is. Below we address the clarifications requested by the referee.

2) Ice Camera; hourly particles are analyzed, if heavy snow happens, crystals will cover the glass in a few seconds, if ice fog/DD will be covered in a few seconds also. What does really mean analyze the data hourly? To me nothing important having this data set, except some selected ice crystals. You say 5 micron resolution, are you sure? Fig. R1 and R2 have scale of 1000 micron. I cant see particles less than 100-200 micron. What is going on here?.

→ We recall again that measurements are performed in Antarctica and not in the Arctic. The precipitation rate in Concordia is so weak that the ICE-CAMERA plate is fully covered of precipitation only on very special occasions, approximately 10-15 days per year. Ice fog never covers the plate because it is electrically-heated and the particles sublimated after each photo.

The resolution is actually 5 microns (7-10 microns when the focusing device is not at its best). The maximum size on the plots presented in Figs R1 and R2 is indeed 1000 microns but there is no link with the image resolution. And, in any case, the picture is compressed for sending it via E-mail to Italy. Consequently, the overall quality of the Figure is worsened.

3) Looking at the data you have, I don't see fog particles?

→ See reply to the comments #6.

4) Fig. 9; a) IWC and b) PF (precip flux); when I see highest IWC, there is no precip? How can I trust this image/fig?

→ In the microphysics scheme inserted in ARPEGE, above a threshold value (based on a formulation), the cloud water (or ice) is transformed (auto conversion) into precipitation (solid or liquid). After, in the layer just below and during the same time step, the evaporation of precipitation is computed (only if the relative humidity is less than 100%). But, in general, the evaporation of precipitation is very small.

So, in Fig. 9, the model starts to create some IWC (Ice Water Content) and, in one layer (~3 km), the value becomes greater than the threshold value (*Qc_crit*). Consequently, precipitation is generated in order to reduce IWC to *Qc_crit*. The layer below is probably dryer and then precipitations are evaporated.

In our system, the threshold value for auto conversion depends on the environment but it is around 10^{-5}.

5) Also; 0.015 mm/day PF=0.0015 mm/day; this means no precipitation basically. How do you explain this?

→ See reply to the comments #4. But we agree with the reviewer, the amount of precipitation is very small in the model. This is probably why precipitation disappears by evaporation. This only means that the model evaluates that some ice cloud droplets start to fall in precipitation because IWC > *Qc_crit* for some time steps.

6) Fig. 8; integrated over 1 hr? you have 1000/hr=(1000/3600) /(Lsec)~0.3/(sec), to me this is a very low number (certainly do not represent ice fog). What is the sampling area (page 10)? If I assume 10x10cm2, and 10 cm/sec fall speed, this makes about 0.2/L which is very low number, do you call this ice fog, DD, or snow crystals? I see no clear comparison or calculations of ice microphysical properties with other studies.

→ The picture is indeed taken every hour. Then the plate is heated for 15 minutes and the collection restarts. Because the collection time is approximately 45 minutes and is not reproducible, the data recorded from the ICE-CAMERA are quantitatively not reliable, but the size and the shape of deposited particles are.

The question relative to the nature of the particles deposited cannot be answered with our study for several reasons. The distinction between ice fog and diamond dust was asked to be reviewed by the referee in the previous version of the manuscript. Unfortunately, the paper Gultepe et al. (2013) and related literature only refer to arctic data. We have to recall that the precipitation rate in Concordia is much smaller than the rates observed in the Arctic, with concentrations of

less than 1000 part/l. Moreover, "arctic" ice-type at Concordia is probably undetected by the ICE-CAMERA because of the small size/deposition rate of the tiniest crystals. Finally, we cannot state with our own measurements and modelling studies whether the low ice precipitation episodes at Concordia are diamond dust or ice fog episodes. This is the reason why we have modified our conclusions together with the abstract and the title of the revised version of the manuscript.

7) Fig. 6; this is what? Absolute humidity? Or cloud water content? Please show IWC and RH for the same case from MWR and lidar, and then model simulations.

→ As already written in the Figure caption, Figure 6 shows the "Time evolution of **absolute humidity** from 15 March to 8 April 2011 above Dome C as measured by the HAMSTRAD radiometer from 0 to 5 km."

8) I feel that authors are pushing their results desperately to be published; in fact, publishing these kinds of work should be careful performed. This manuscript should be rejected and resubmitted with more focused way and it should be designed properly.

I suggest authors should follow up the structure below
1) Set up clear goals
2) Better description of observations
3) Better comparisons of the results with others
4) Focus on only DD/Snow or IF, and present results that comparable with others, if not, explain why? Their characteristics are not the same
5) Provide insight to figures, IWC, Ni, precip flux etc.
6) Show simulation of model matching observed quantities.
7) Clear conclusions;
a) Found that Ni is comparable …..
b) DD Ni was ……
c) NWP results were …..
d) …….
e) New sensor showed that…….

→ Please see our response to organization above (reply to the comments #1).