

## ***Interactive comment on “Numerical simulation of a winter hailstorm event over Delhi, India on 17 January 2013” by A. Chevuturi et al.***

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Received and published: 20 November 2014

REVIEWER #2 1 Section 3.2 (2nd paragraph, line 20): it is mentioned that “. . . Graupel precipitation or sedimentation is not observed. . . but hail precipitation. . .”. Is the graupel precipitation and sedimentation are same thing?

Reply: Sedimentation is a microphysical process of falling of ice crystals from the cloud. It is slightly different in definition than precipitation which is the process of any hydrometeor reaching the surface. Here in the paper, the process being discussed is the ice crystal (hail or graupel) precipitating on to the surface. Hence now in the manuscript only the term precipitation is indicated.

2 When hail precipitation is mentioned, is it mean the rainfall from hail microphysics  
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scheme or rainfall is in the form of hail hydrometeors. Or Fig.9 the comparison shown is between the rainfall outputs from two different schemes.

Reply: Hail precipitation refers to only the ice particle precipitation in the form of hail. Fig. 9 represents the ice (hail) particle precipitation to the surface with the hail option of the WRF simulation. This does not include any liquid water precipitation. To make it more clear graupel/hail precipitation is now defined in the manuscript as “precipitation of ice particles in the form of graupel/hail which does not include liquid water precipitation”. Also graupel precipitation in the graupel option is not shown as there was not graupel precipitation observed in that model simulation.

3 In the model configuration, whether the cumulus scheme is active in the inner most domains (1/3/9km)?

Reply: Cumulus is not active in the inner most domains of 1km and 3km; and this is mentioned in the last lines of the section 2 of the manuscript. The manuscript lines are referred below: “It is to be mentioned that in both simulations 3km and 1km resolution nests were simulated with explicit representation of cumulus parameterization scheme. As model for simulations at horizontal resolutions smaller than 3km, estimates the precipitation by the cloud microphysics scheme itself (Gomes and Chou, 2010).”

4 Model run have happened at 27/9/3/1 km respectively (Section 2). In figures, plots were shown identifying it as “model out”, is this the output from 1km run or 3km ? For example in fig.4 it is mentioned the model output with hail option/graupel option at 27km but in fig.5 ( and in other figures) it is mentioned just the “model output” with hail option, so is it the same 27km or 9/3/1 Km. Author should mention the resolution of the model output compared with analysis in each figure.

Reply: In the figure captions the WRF simulations are identified as “model output”. With each figure the horizontal model resolutions have been indicated in the figure captions. In figures such as Fig. 5 horizontal model resolution remains same for the two different model simulations (with hail and graupel options). Authors have rechecked that

each figure caption containing model output representation clearly states the horizontal model resolution.

5 How moisture transport were calculated in analysis and from the model or provide reference.

Reply: The reference for calculation of moisture transport has been added in the manuscript as Howarth (1983).

6 Fig.6, precipitation has been compared with MERRA, it would have been robust, if an observed product such as TRMM used for comparing precipitation (Fig.6). Though TRMM data was mentioned in section.2, perhaps it is not used for comparing results.

Reply: Precipitation of the model simulation has been compared using TRMM observation data only. The Fig. 6 caption states MERRA data, but this is erroneously written in the figure caption only. The discussion in the manuscript corresponding to the figure correctly states that the observation analysis of precipitation is TRMM data. The error in the figure caption is corrected accordingly.

7 Fig. 11 vertical winds (+ve/-ve) mentioned, mention signs refer to upward or downward motions.

Reply: Vertical wind positive values show upward motion and negative values show downward motions. Corresponding changes to clarify this point have made in the second paragraph of section 3.3.

8 Fig.9 Hail precipitation is shown at 27km. It is better to show result at higher resolution (3/1 km)

Reply: Fig. 9 shows hail precipitation at 27km resolution but not in high resolutions as model output at higher resolution did not hail particle precipitation. Thus, the figures were not included in the paper.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 6033, 2014.

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