General comments:

The manuscript presents analysis of cloud and precipitation development related to the seeder-feeder mechanism, based on ground-based Ka-band millimeter-wave cloud radar (MMCR) and microwave radiometer (MWR) in Xi'an, China. Through analysis of the reflectivity factor and the radial velocity of cloud particles detected by MMCR, and the retrieved cloud dynamics parameters (vertical velocity of airflow and falling velocity of cloud particles), the authors showed that the reflectivity factor in the cloud are significantly enhanced during the seeder-feeder period, and the magnitude of the enhancements are different for clouds with different HD (the height difference between the seeding cloud base and the feeding cloud top) and ESD (the effective seeding depth). While the manuscript is understandable as a whole, many phrases and explanations are not clear or even incorrect. I think the quality of the manuscript needs a significant improvement.

Response: Thank you very much for your nice comments. Your question and suggestion are very helpful for us to improve the quality of our paper. We appreciate the reviewer's thoughtful review and constructive comments. The following is our point-to-point replies.

Specific Comments:

1. When explaining the seeder-feeder mechanism (Lines 31-33), the authors said: When these seeders meet lower cloud droplets with ice phase or in supercool water state, the droplets will grow larger by riming or vapor deposition via the Wegener-Bergeron-Findeisen effect (Bergeron 1935; He et al., 2022). This is conceptually incorrect. It should be the ice particles that grow in the WBF process, not the droplets.

   Answer: Thank you very much for your nice reminding. We went through the references, and you were right. When ice crystals meet lower cloud droplets with ice phase or in supercool water state, they grow by riming or vapor deposition via the Wegener-Bergeron-Findeisen effect (Bergeron 1935; He et al., 2022; Ulrike Proske et al., 2021).

2. Probably the most significant contribution of this article is by defining the height

difference between the seeding cloud base and the feeding cloud top (HD) and the effective seeding depth (ESD), the authors found that the seeding effect are different for cloud with different HD. However, the similar expressions "The lower and thinner the HD height was, the lower and thicker the ESD height was. On the contrary, the higher the HD height, the higher and thinner the ESD height" appeared in the Abstract (Lines 20-21) and in the Conclusions (Lines 529-530) are hard to understand. The heights of HD and EST cannot be described as thinner or thicker.

Answer: Thank you very much for your nice reminding. The abstract (Lines 529-530) and conclusion (Lines 529-530) have been revised as follows:

Abstract （Lines 20-21）: The lower the height and thinner the thickness of the HD, the lower the height and thicker the thickness of ESD; On the contrary, the higher the height and the thicker the thickness of the HD, the higher the height and the thinner the thickness of the ESD.

Conclusion（Lines 529-530）: The lower the height and thinner the thickness of HD, the lower the height and thicker the thickness of ESD.

More detailed comments:

1. The title may be changed as "The characteristics of cloud macro parameters caused by seeder-feeder process inside clouds measured by millimeter-wave cloud radar in Xi'an, China";

Answer: Thanks. The title has been changed based on your suggestions.

2. Line 13: Change "China Xi'an" to "Xi'an, China";

Answer： Thanks. It has been changed into "Xi'an, China".

3. Lines 18-19: "But there are different enhancements among the reflectivity factor profiles for the three seeding-feeding processes" may be modified to "But the magnitudes of the enhancements among the three seeding-feeding processes are different" to avoid duplication with the previous sentence;

Answer: Thanks. That has been modified.

4. Line 26: “lead” may be modified to "promote";

Answer: Thanks. That has been modified.

5.Lines 29-30 are not clear;

Answer: The sentence has been rewritten as follows: “The seeder-feeder process is a phenomenon that ice crystals as seeder, from an upper cloud fall into a lower cloud or a lower-lying part of the same cloud, which is either liquid, ice or mixed phase.” Thanks.

6. Lines 34-35: There are syntax errors in this expression;

Answer: Thank you very much, the sentence has been rewritten as follows: “Therefore, it is important to understand the seeder-feeder mechanism, which can be helpful to improve the representation of cloud processes in weather and climate models, and weather forecasts of precipitation, and ultimately to reduce uncertainty in climate simulations. “

7. Lines 36-38: The sentence is incomplete or not clear;

Answer: The sentence has been rewritten as follows: “The seeding-feeding phenomenon has been studied by observations and simulations in operations of the artificial precipitation enhancement, and it was found that the distinct changes in both cloud and precipitation properties. (French et al., 2018; Ramelli et al., 2021; Dong et al., 2021)”

Thanks.

8. Lines 42-44: There is logical problem in this sentence;

Answer: The sentence has been rewritten as “In the 1980s in China, Hong et al., (2011 and 2012) established a cloud model that simulated the formation of stratiform clouds. In the model, the seeding-feeding process was emphasized.”

9. Lines51-54: The expression is not clear to me. What scientific questions are still existing related to the seeder-feeder process?

Answer: This paragraph has been revised into “The microphysical parameters of the seeder-

feeder process appeared within mixed-phase clouds have been investigated by using the ground-based remote sensing instruments (Ramelli et al., 2021). However, there is still a lack of the specific characteristics, such as the height difference between the seeding cloud base and the feeding cloud top (HD) and the effective seeding depth (ESD), to represent the feature of the seeder-feeder process. In the meantime, the characteristic of air vertical motion, particle terminal velocity inside cloud during seeding-feeding process is still poorly understood."

10. Line 57: Why several cloud layers are needed?

Answer: Because our study focuses on the external "seeding-feeding" process that occurs between double-layer clouds, rather than the effect of the upper layer on the lower layer within the same cloud body. Thanks.

11. Line 64: "the seeder-feeder processes" or "the seeder-feeder process"?

Answer: It has been changed into "the seeder-feeder process". Thanks.

12. The sentence in Lines 66-67: "The parameters of microphysics, dynamics and thermodynamics during the seeder-feeder process were focused on analysis" is not clear to me.

Answer: This sentence has been deleted in the revised manuscript. Thanks.

13. Line 83: "observations data" may be changed to "observational data".

Answer: OK, Thanks. "observations data" has been changed to "observation data".

14. Line 109: "which reduces the trouble of eliminating terrain clutter in observation data quality control", needs to be rewritten.

Answer: OK, Thanks. It is now rewritten as "which reduces errors of the terrain clutter in observational data"

15. What does "air haze" in Line 110 mean?

Answer: It means aerosol. So, it has been modified to "aerosol". Thanks.

16. Lines 109-113 are not clear.

Answer: This paragraph has been revised into "The echo signals of floating debris in the low-level atmosphere have the characteristics of a small reflectivity factor, low velocity, and large spectral width. To further eliminate interfering wave information, we obtained the data quality control threshold by counting the characteristic changes in planktonic echoes in the boundary layer under cloud free conditions (Yuan et al., 2022). " Thanks.

17. Lines 120-121: the expression "Because the descending the cloud particles velocity in different phase states is different, the influence on the vertical velocity of the airflow in the cloud is different" needs to be written.

Answer: Now, the sentence has been rewritten as "The falling speed of cloud particles varies due to the influence of phase state, which in turn affects the magnitude of vertical airflow velocity." Thanks.

18. Line 128: What does mean by "In the identified I supercooled water region"?

Answer: That is a clerical error. It has been modified as "In the identified supercooled water region". Thanks.

19. Line 129: "When there was a drizzle, the SP of MMCR usually shows a bimodal distribution": a drizzle?

Answer: It has been modified as ""When it drizzles, the SP of MMCR usually shows the bimodal distribution." Thanks.

20. Line 138: change "this season" to "these seasons";

Answer: OK, thank you very much.

21. Line 141: "cloud bottom" should be changed as "cloud base" , similar changes should also be made in other places;

Answer： OK, thank you very much.

22. Lines 139-141: How the heights of cloud top and cloud base are defined?

Answer： It is easy to identify cloud base and cloud top based on the echo profiles measured by millimeter wave cloud radar, which has been descripted in the reference published in AMT (Yuan yun, 2021 AMT). The heights of cloud top and cloud base are usually clear in the echo profiles. Thanks.

23. Lines 152-153: "…… seeding time t2 at 98.2min, and feeding cloud development duration at more than 2hr 30min" needs rewritten.

Answer： The sentence has been rewritten as "It also shown that the bilayer cloud is stable during this period, with THSC stable at 8 km, BHSC at 5.5 km, THFC at 4.2 km, DH at 0.85 km. The seeding process lasts for about 98.2 minutes (t2), and feeding cloud development duration reaches more than 2 hours and 30 minutes" . Thanks.

24. Line 166 and several other places: "the final falling velocity" is "the terminal fall velocity"?

Answer： OK, in the revised manuscript, "the final falling velocity" has been changed to "the particle terminal velocity". Thanks.

25. Lines 170-171: why the unit of width of the velocity spectrum is m/s?

Answer： The following is our description. the width of the velocity spectrum is the degree to which the Doppler velocity of particles within a radar's effective detection volume deviates from its average value. The larger the difference in particle size, the greater the corresponding difference in falling end velocity, resulting in a wider Doppler velocity spectrum. The formula 1 is the definition of the width of the velocity spectrum, so the unit of width of the velocity spectrum is m/s. Thanks.

$$SP = \sqrt{\frac{\sum_{i=V_L}^{V_R}(i - V_r)^2 \times (S_i - P_N)}{\sum_{i=V_L}^{V_R}(S_i - P_N)}} \quad (1)$$

Here, V_L: Doppler velocity at the left endpoint of the Doppler spectra (unit: m/s); V_R: Doppler velocity at the right endpoint of the Doppler spectra (unit: m/s); S_i: cloud signals (unit: dBm); P_N: noise level (unit: dBm);

26. Lines 184-186: "But in some altitudes, there are the airflow sinking movements, which can be explained the needs of airflow sinking movement short-term to achieve mass balance": What does this mean?

Answer: For easy comprehension, the sentence has been rewritten as "There is rarely a large-scale and prolonged air sinking and rising movement in the seeding cloud and feeding cloud, but alternating upward and downward movements occur. ". Thanks.

27. Line 187: "the sinking velocity of the cloud particles is in the range of –1~ –4 ms^{-1} during seeding process": What size cloud particles can get such falling velocity? The sinking velocity is the terminal fall velocity?

Answer: According to Fig. 3 in the manuscript, the terminal velocity of particles in the seeding and feeding area is from -1 to -4 m/s, but most of them are less than -2.5 m/s. According to the cloud phase in Fig. 4, the particles are snowflakes in the cloud seeding and feeding area. The particle size is related to the shape of snowflakes and the final falling velocity, so it difficult to accurately quantify particle size. Table 1 lists the relationship between snowflake diameter and terminal velocity.

Table 1 the relations of cloud particles and diameter (Tao R., et al. TGRS, 2020)

Study	Relation	Snow Type
Brandes (2002) [22]	$v_t = -0.1021 + 4.932D - 0.9551D^2 + 0.07934D^3 - 0.002362D^4$	Rain
Jeong-Eun (2015) [23]	$v = 1.03D^{0.71}$	Needle
Locatelli and Hobbs (1974) [24]	$v = 1.3D^{0.66}$	Lump graupel
	$v = 0.79D^{0.27}$	Densely rimed aggregates
	$v = 0.81D^{0.16}$	Unrimed aggregates
This study	$v = 1.03D^{0.25}$	low terminal velocity cases
	$v = 1.29D^{0.29}$	high terminal velocity cases

According to the speculation from table 1, the size of the snow particles in the cloud is distributed between 1mm and 6mm, and most of them are below 3mm.

Yes, the sinking velocity is the particle terminal velocity. Thanks.

28. Lines 207-210: “During being seeded, ice particles were the main component in the cloud. After being seeded, the ice particles in the lower part of the feeding cloud lasted for a long time (maintaining the whole t3 period), while the supercooled water layer at the top was obvious”: This needs more explanation.

Answer:

“Before seeding, the larger downward mean Doppler velocity (Figure 2b) was detected in the lower part of the seeding cloud, which indicates that the cloud process has transformed from ice to snow with large particle sizes. Snowflakes, as seeders, fall into the mixed phase cloud containing supercooled water, so that the Wegener-Bergeron-Findeisen effect occurred. That effect causes the mixed phase cloud to rapidly transform into ice. Because it takes time for particles to fall, so the seeding will continue to the middle and lower parts of the feeding clouds, and snow keeps for a long time (maintaining the entire t3 period); In the top region of the unaffected feeding cloud, the cloud phase remains supercooled water, which is consistent with the observation results in Shupe (2007).” Thanks.

29. Lines 211-212: “The instantaneous water vapor flux structure (Fig. 4b) indicates that the seeding cloud is smaller than the feeding cloud”: smaller in size or water vapor flux?

Answer: the sentence has been rewritten as “From Figure 4, it can be seen that the instantaneous water vapor flux of the seeding cloud is smaller than that of the feeding cloud.” Thanks.

30. “seeing-feeding” in Lines 213-214 should be “seeding-feeding";

Answer: OK, thank you very much.

31. Lines 229-233: not clear;

Answer: This paragraph has been revised as “The cloud particle with larger diameter has a larger falling speed under the action of gravity. In order to reveal the relationship between particle size and echo signal in the process of seeder and feeder. The statistical classification method of equal samples is adopted to find the relationship. All signal values (echo reflectivity,

radial velocity, spectral width, particle falling velocity, and vertical airflow velocity) are reordered according to their corresponding echo reflectivity values from small to large, and then compared in the equal sample." Thanks.

32. Line 236: Change "Following to this principle" to "Following this principle";

Answer: OK, thank you very much.

33. Lines 240-241: "……the corresponding average profile of cloud particle parameter profile for the three intensity echoes is also gained" needs rewritten;

Answer: It has been rewritten as "…… the corresponding average profile of cloud particle parameter for the three intensity echoes is also obtained." Thanks.

34. Lines 287-288: "…… after the seeding, the cloud particle size distribution and particle velocity of the bilayer cloud reach a relatively balanced and stable state through complex thermodynamic and dynamic interactions": needs more physical explanation.

Answer: Due to the fact that echo reflectivity factor, radial velocity, and falling terminal velocity reflect particle size, and spectral width reflects particle size distribution and particle category. in the end of seeding, the cloud particle size distribution and particle velocity of the bilayer cloud may reach a relatively balanced and stable state through the complex microphysical and dynamic interactions in the t2 period." Thanks.

35. Lines 310-312: "Therefore, the Effective Seeding Depth (ESD) is defined as the height difference between the top height of the feeding cloud and from the height down to the height of the maximum correlation coefficient, which represents the influence of seeders on the seeding cloud": I do not understand.

Answer: We confused. The last three words are " the feeding cloud" in the sentence. In the revised manuscript the error has been modified. Thanks.

36. What does it mean by "sowing effect" in Line 315?

Answer: That is a clerical error. “sowing effect” has been changed into “seeding effect” in Line 315. Thanks.

37. There are more expression problems in the remaining part of the text. I suggest the quality of the whole text to be carefully checked and revised.

Answer: Thanks. We have checked and revised manuscript sentence by sentence to avoid mistakes.