

***Interactive comment on* “Retrieval of cloud liquid water distributions from a single scanning microwave radiometer aboard a mobile platform – Part 2: Observation system simulation experiments” by D. Huang et al.**

Anonymous Referee #2

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Major Comments:

1. p. 12066, lines 12-13: It must be clarified that in the ground-based setup, the contrast is not only between the clouds and the cosmic microwave background, but also with the wings of many resonant lines in the Earth’s atmosphere. This is addressed in Sect. 4.3 in terms of the water vapor contribution even at imaging frequencies (or cloud measurement frequencies). This is quite an important distinction.
2. p. 12067, lines 5-10: What are the spatial and temporal resolution needed to

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Interactive Discussion

Discussion Paper



improve cloud representations in numerical models ?

3. p. 12067, lines 14-17: In terms of its use to estimate LWP, radar also suffers from the ambiguity of cloud particle sizing since the cloud particle size distribution is relatively unknown.

4. p. 12068, lines 20-25: What are suitable cloud capture times ? In other words, how rapidly do the clouds change ? A chart showing various cloud types and their evolution time would be helpful.

5. p. 12069, lines 15-25: What are the sampling time for the airborne setup and the ground based setup? Can faster sampling rates be achieved without sacrificing sensitivity for the airborne version ? Could this result in the same number of scan angles as in the ground based setup?

6. p. 12071, line 15: "transmission" is ambiguous and should be called "transmissivity" or similar.

7. p. 12071, Eqn. (2): Eqn.(1-6) are repeated from [1]. The authors may consider removing eqn.(1-6) from this paper. It is not clear in what direction the m rays are, even in [1]. The authors should explain this maybe with the help of an illustration. The description of methodology needs to be rewritten to express how the truncated SVD and L-curve retrieval technique, explained in [1], is regularized using the L1 and L2 regularization method. The L1 and L2 norm should be expressed in terms of the retrieval parameters and the observed brightness temperatures.

8. p. 12073, line 19: "calculating the distribution": Is the spatial distribution meant here? In general, "distribution" could also mean the statistics, as in a PDF.

9. p. 12073, line 26: The authors mention using various types of a priori knowledge but do not explain what they did for their retrieval. Did their least squares solution use any kind of a priori information ? If so, what was the a priori?

10. p. 12074, line 22: "Fig. 2" should be "Fig. 3".

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Discussion Paper



11. p. 12077, lines 5-6: "miles per hour" This and every other scientific journal requires the use of mks units in normal situations. (Some exceptions are made, e.g. cgs units for magnetic quantities.) Change to mks.

12. p. 12077, lines 20-25: The authors mention that only rays within 80 degrees off the nadir or zenith are considered due to sidelobe contamination. Can the authors give some quantitative results for the sidelobe contamination suffered for the angle scanned closest to the horizon ? What are the main beam efficiency and first sidelobe level of the radiometer antenna?

13. p. 12079, lines 20-21: This 3 K maximum uncertainty only models directional errors (azimuth difference between the radiometer viewing direction and the wind-wave direction). At significant wind speeds, the azimuthally-averaged emission uncertainty can be much larger.

14. p. 12082, lines 8-9: "range of viewing angles is usually less than 140 degrees" How was this quantitatively determined? Through only the aircraft data used in Part 1 of this paper? The source of this quantity should be given or cited.

15. p. 12083, Conclusions: The most significant new contribution of this paper is the comparison of the performance of the L1 (total variation regularization) with that of the L2 norm (Tikhonov regularization). It is commonly thought that L2 is generally easier to solve and tends to provide better results than L1 norm. Therefore, the result (L1 norm better than L2 norm) obtained by the authors is an unusual result. The authors need to clearly explain the cost function in each case in terms of the observed brightness temperatures and the absorption coefficients that are retrieved. Do the authors have a "real" understanding of why the L1 norm inversion provides a better result than the L2 norm ?

16. p. 12097, second line: "expense of longer measurement time." It needs to be clarified that this "expense" is the loss of ability to measure temporally varying clouds.

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References : [1] Huang, D., Liu, Y., and Wiscombe, W.: Determination of the cloud liquid water distribution using 3D cloud tomography, J. Geophys. Res., 113, D13201, doi:10.1029/2007JD009133, 2008a

More Minor (yet still important) Comments: The paper needs to be proofread carefully by a native English speaker. There are many, many instances of substandard English usage. Comments on some of the English errors are given below.

1. p. 12066, line 3: "for the tomographic retrieval purpose." -> "for the purpose of tomographic retrieval."
2. p. 12066, line 6: "by means of observation system simulation experiment." -> "by means of an observation system simulation experiment."
3. p. 12066, line 16 AND p. 12082, line 24: "overlapping" -> "overlap"
4. p. 12066, line 19: "at the altitudes between 500 m to 1000 m" -> "between the altitudes of 500 m and 1000 m"
5. p. 12066, line 22: Delete "by which" since it is unnecessary.
6. p. 12066, line 25: "enormous influences" -> "large influences" or "important influences". This kind of overexaggeration does not belong in a scientific paper.
7. p. 12067, line 1: "one of the most poorly represented component" -> "one of the most poorly represented components"
8. p. 12067, line 2: Delete "the" from "in the predictions"
9. p. 12067, line 4: "long-term consistent cloud observations" -> "consistent, long-term cloud observations"
10. p. 12067, line 7: Delete "evaluate thus to". It does not make sense here.
11. p. 12067, line 8: "observation techniques" -> "observational techniques"
12. p. 12067, line 10: "can only sample a small volume of a cloud," -> "can sample

C5483

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Discussion Paper



only a small cloud volume,"

13. p. 12067, line 10: "vertical-pointing" -> "vertically-pointing"

14. p. 12067, line 12: "vertical integral of the" -> "the vertically-integrated"

15. p. 12067, line 18: "a new promise for" -> "great potential for"

16. p. 12067, line 21: "boarded on" -> "deployed on"

17. p. 12067, line 21: "of cloud water distribution" -> "of a cloud water distribution"

18. p. 12067, line 26: "is depended on" -> "depends on"

19. p. 12067, line 27: "number of microwave radiometer" -> "number of microwave radiometers"

20. p. 12067, line 28: "ground radiometers" -> "ground-based radiometers"

21. p. 12068, line 3: "limits ... in applications" -> "limits ... to applications"

22. p. 12068, line 6: "of the similar quality" -> "of similar quality"

23. p. 12068, line 7: "a tomographic reconstruction would require" -> "tomographic reconstruction requires"

24. p. 12068, line 15: "similarly as" -> "similarly to"

25. p. 12068, line 16: Add a comma after "Louisiana" to separate two independent clauses.

26. p. 12068, line 19: "because of scale mismatch" -> "due to a scale mismatch"

27. p. 12068, line 21: "for cloud tomography the number of directions each cloud pixel being viewed is one of the most important factors" -> "one of the most important factors for cloud tomography is the number of directions from which each cloud pixel is viewed"

28. p. 12068, line 22: "The use of dual-antenna" -> "The use of a dual-antenna system"

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29. p. 12068, line 27: Delete "real" here. It does not add to the meaning.
30. p. 12068, line 28: "while the platform passing the interested cloud." -> "while the platform passes the cloud of interest."
31. p. 12069, line 4: "revealed" -> "demonstrated"
32. p. 12069, line 5 AND p. 12076, line 19: "compared with" -> "compared to"
33. p. 12069, line 16: "aircrafts." -> "aircraft." "aircraft" is a collective noun in English. "Aircrafts" is never used.
34. p. 12069, line 17: Delete "from" between "to fly" and "above"
35. p. 12069, line 18: "Figure 1a" There is no Figure 1a, only Figure 1.
36. p. 12069, line 19: "in different color." -> "in a different color."
37. p. 12069, line 21: "in the same figure with matching color." -> "in the figure." The second part is redundant, and the same figure is obvious.
38. p. 12069, line 22: Add a comma between "ground-based" and "and it".
39. p. 12069, line 29: "of cloud tomography." -> "for cloud tomography."
40. p. 12070, line 3: "possible improvement on" -> "possible improvements to"
41. p. 12070, line 6: "Observation system simulation experiment" -> "An observation system simulation experiment"
42. p. 12070, line 8 AND line 12 AND line 14: In each case, delete "some" before "virtual cloud", "test clouds" and "prescribed radiometer specifications", respectively.
43. p. 12070, line 10: "The forward model is" -> "The forward model contains" The forward model does much more than this.
44. p. 12070, line 13: Delete "simulation", which here is redundant with "model".

Interactive
Comment

45. p. 12070, lines 14-15: "in a way consistent with radiometers observe." -> "consistent with the way radiometers observe."
46. p. 12070, lines 21-22: "between the 800 mb level to about 700 mb." -> "between the 800 mbar and 700 mbar levels."
47. p. 12070, line 24: "clouds reside" -> "clouds are located"
48. p. 12071, line 17: Delete "real" between "A" and "radiometer measurement".
49. p. 12071, line 18: "can be characterized" -> "can be partially characterized" [Of course the size and shape of an antenna do not completely determine its gain; ohmic loss is involved as well. Do you mean antenna directivity instead of antenna gain here and in eqn. (2)?]
50. p. 12071, line 19: "antenna beam with." -> "antenna beamwidth."
51. p. 12071, line 22: "the gain" -> "the power gain" [for clarification]
52. p. 12072, line 2 AND line 5: Delete "the" before "Gauss quadratures"
53. p. 12072, line 11: "equal- sized pixels" -> "equally-sized pixels"
54. p. 12072, line 15: "microwave emissions" -> "microwave emission" "Emission" is a collective noun in English.
55. p. 12072, line 21: "Atmospheric absorption coefficient" -> "The atmospheric absorption coefficient"
56. p. 12073, line 2: "consists generally of " -> "generally consists of"
57. p. 12073, line 5: "are those of" -> "are given by"
58. p. 12073, line 9: Delete the comma in "temperature, and radiometer frequency." A comma is never used between items in a series with only two items.
59. p. 12073, line 12: "with current radiosonde technique." -> "with current radiosonde

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techniques."

60. p. 12073, line 18: "Eqs. (2)" -> "Eqs. (1) and (2)"

61. p. 12073, line 23: "for vector x," -> "to obtain vector x,"

62. p. 12073, line 23: "of limited radiometer view of clouds" -> "of a limited range of radiometer viewing angles of clouds"

63. p. 12073, line 26 to p. 12074, line 1: "more physically creditable retrievals" -> "physically credible retrievals"

64. p. 12074, line 10: "easy for numerical implementation" -> "easy to implement numerically"

65. p. 12074, line 11: "usually penalizes more" -> "usually has larger errors"

66. p. 12074, line 12: "One of our previous study" -> "One of our previous studies"

67. p. 12074, line 13: "around cloud top" -> "around the cloud top"

68. p. 12074, line 15: Start a new sentence after "tens of meters." using "Instead,"

69. p. 12074, line 18 AND p. 12075, line 27 AND p. 12081, line 6: "doesn't" Contractions are inappropriate for scientific writing. No exceptions.

70. p. 12074, line 21 AND p. 12075, line 19: "present" -> "presented"

71. p. 12075, line 6: "should have no preference the scale" -> "should have no bias that depends on the scale"

72. p. 12075, line 8: Delete "the" between "suppress" and "large"

73. p. 12075, line 9: "to pose a poor capability" -> "to possess a poor capability"

74. p. 12075, line 14 AND line 16: "such as the" -> "using techniques such as the"

75. p. 12075, lines 23-24 AND p. 12082, line 13: Remove the parentheses around this

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pseudo-sentence and make it into its own sentence.

76. p. 12075, line 25: "retrievals from" -> "results of" [to avoid using "retrieval" twice]

77. p. 12076, lines 2-3: "of cloud case and regularization technique" -> "of cloud cases and regularization techniques"

78. p. 12076, line 4: Delete the comma in "Tikhonov regularization, and TV regularization." A comma is never used between items in a series with only two items.

79. p. 12076, line 4: In this same sentence, the sub-parts of Figure 4 corresponding to each case need to be specified.

80. p. 12076, line 12: "clear sky at the reference images" -> "clear sky in the reference images"

81. p. 12076, line 13 AND p. 12077, line 28 AND p. 12078, line 3: "imposed to" -> "added to"

82. p. 12076, line 18: "solving ill-posed ... problem." -> "solving the ill-posed ... problem."

83. p. 12077, line 3: "among are" -> "among them are"

84. p. 12077, line 6 AND p. 12081, line 2 AND p. 12081, line 3 AND p. 12083, line 26: "platform moving speed" -> "speed of platform motion"

85. p. 12077, line 13: "3.0 K" -> "2.7 K" Writing two significant figures mean that the number is precise to two significant figures. You have rounded off to one significant figure here.

86. p. 12077, line 16: "less distinctive with clouds." -> "more similar to microwave emission from clouds."

87. p. 12077, line 18: "makes them" -> "makes it"

88. p. 12077, line 22: "not specified explicitly." -> "not specified otherwise."

C5488

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Discussion Paper



89. p. 12077, line 23: "have a 0.5 K random noise with" -> "have 0.5 K random noise and"
90. p. 12077, line 25: "off the nadir or zenith" -> "from nadir or zenith"
91. p. 12077, line 25: "ground clutters" -> "ground emission" [Ground clutter is specific to radar scattering.]
92. p. 12078, line 1: "is strongly depended on" -> "strongly depends on"
93. p. 12078, line 1: "incident angle" -> "incidence angle" [by convention in radiometry]
94. p. 12078, line 12: Add "in Figure 5," after "stratocumulus cloud case"
95. p. 12078, line 13: "than the error of" -> "than that of" [to avoid redundancy]
96. p. 12078, line 16 AND line 19 (similar case): "at clear sky" -> "in clear sky"
97. p. 12078, line 16: "And for the patchy cumulus case," -> "In the patchy cumulus case (Figure 6),"
98. p. 12078, line 20: "such a high fidelity" -> "such high fidelity"
99. p. 12078, line 21: "tell their difference" -> "tell any difference from the reference image"
100. p. 12078, line 28: "of ground-based setup" -> "of the ground-based setup"
101. p. 12079, line 7: "but the resolving of high-frequency" -> "but resolving the high-frequency"
102. p. 12079, line 14: "contribute" -> "contributes" ["emission" is singular]
103. p. 12079, line 17: "impose" -> "add"
104. p. 12079, line 20: "wind-caused wave" -> "wind-driven waves"
105. p. 12079, line 23: "similar effects on the retrieval as" -> "similar effects on the

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retrieval to"

106. p. 12079, line 27: "between sea surface and" -> "between the sea surface and"

107. p. 12080, line 7: "their differences" -> "the differences"

108. p. 12080, line 9: "It is shown in our previous studies" -> "Our previous studies have shown"

109. p. 12080, line 16: "scanning speed." -> "scanning duration." This is effectively the inverse of speed!

110. p. 12080, line 19: "change of" -> "change in"

111. p. 12080, line 21: "scan faster" -> "scans faster"

112. p. 12080, line 22: "faster radiometer" -> "faster scanning radiometer"

113. p. 12081, line 4: "cycles the radiometers have" -> "cycles the radiometers perform"

114. p. 12081, line 13: "error change" -> "error changes"

115. p. 12081, line 17: "succeeding scan" -> "successive scan"

116. p. 12081, line 19: "one order" -> "one order of magnitude"

117. p. 12082, line 7 AND line 8 AND line 10 AND line 13 AND line 16: "view angle" -> "viewing angle"

118. p. 12082, line 18: "while the aircraft" -> "when the aircraft"

119. p. 12082, line 19: "between ... to ..." -> "between ... and ..."

120. p. 12082, line 19: "beyond" -> "above"

121. p. 12082, line 22 AND line 24: "close to cloud top" -> "close to the cloud top"

122. p. 12082, line 22: "within ... to ..." -> "between ... and ..."

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123. p. 12082, line 25: "will not hold" -> "will not contain"
124. p. 12082, line 26: Delete "content" after "information". It is not needed.
125. p. 12082, line 26: "around cloud top." -> "around the cloud top."
126. p. 12083, lines 2-5 AND line 11: "examine" -> "examined" and "demonstrates" -> "demonstrated" and "It is" -> "It was" and "conduct" -> "conducted" [Describe the other paper in the past tense.]
127. p. 12083, line 4: "the tomographic method" -> "this tomographic method"
128. p. 12083, line 4: "distribution" -> "distributions"
129. p. 12083, line 7: Add "as well as" after "speed,".
130. p. 12083, lines 11-12: "either ... or" -> "both ... and"
131. p. 12083, line 20: "where large discontinuity" -> "where a large discontinuity"
132. p. 12083, line 25: "like" -> "such as"
133. p. 12083, line 28: "The reason relies on two facts:" -> "There are two reasons for this:"
134. p. 12084, lines 1-2: "better beam intersection" -> "more scan-to-scan beam overlap"
135. p. 12084, line 7: "factor playing" -> "factor that plays"
136. p. 12084, line 9: "better overlapping" -> "more overlap"
137. p. 12084, line 15: "minimizing the adverse influence of cloud evolution on" -> "capturing the evolution in time of clouds in"
138. p. 12084, line 17: "important parameter to" -> "important parameter for"
139. p. 12084, line 19: "comparable with" -> "comparable to"

140. p. 12096, first line: "i.e., radiometer scanning speed" -> "proportional to inverse of radiometer scanning speed"

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Discussion Paper

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