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REFORGER 77 SUPPORT -- PART B. TEST OF A SUGGESTED APPROACH TO --ETC(U)
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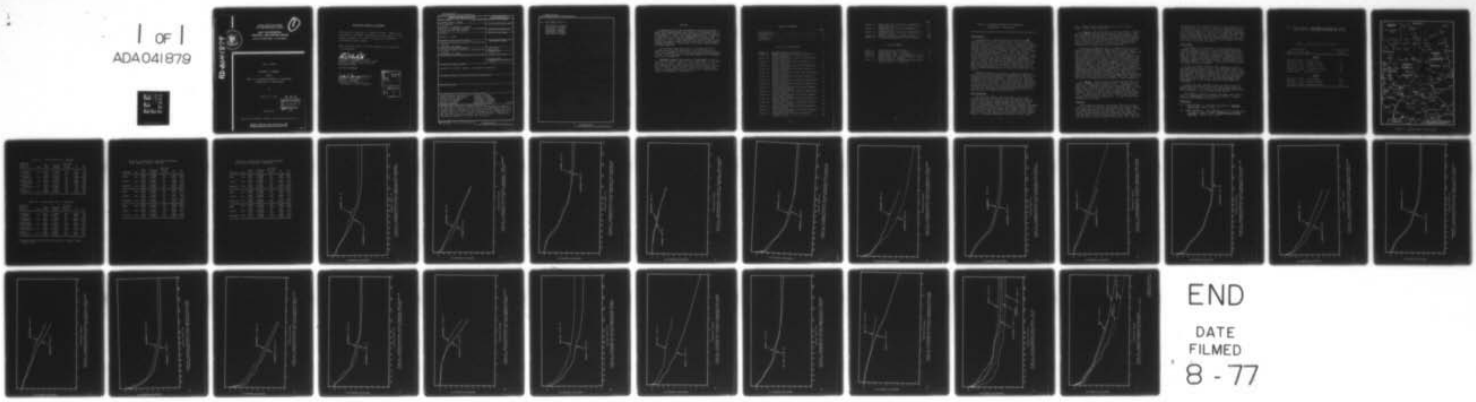

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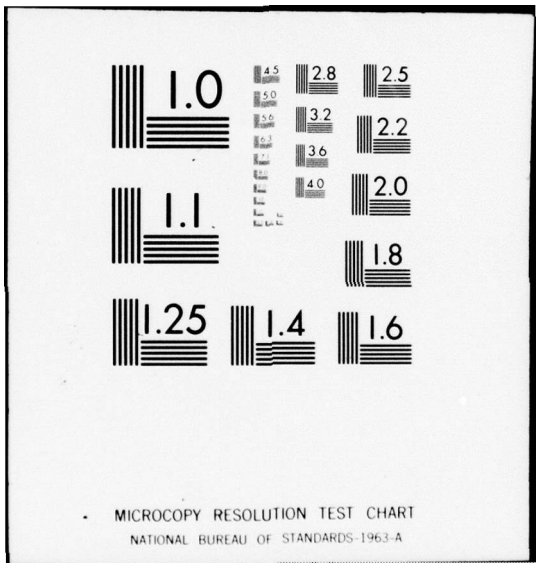
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UNITED STATES AIR FORCE
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USAF ENVIRONMENTAL
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SCOTT AIR FORCE BASE, ILLINOIS 62225

Report 8065B

REFORGER 77 SUPPORT

PART B

TEST OF A SUGGESTED APPROACH TO SPREADING CLIMATOLOGY TO GRID POINTS

by

Murray J. Young

March 1977

REVIEW AND APPROVAL STATEMENT

This report is approved for public release. There is no objection to unlimited distribution of this report to the public at large, or by DDC to the National Technical Information Service (NTIS).

This technical report has been reviewed and is approved for publication.

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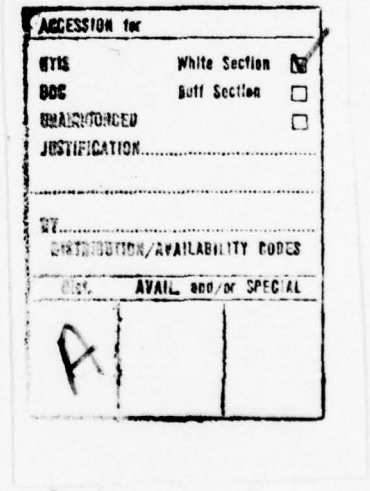

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18. SUPPLEMENTARY NOTES

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Climatological Applications	Feucht, Germany
Meteorological Phenomena	Finthen, Germany
Statistical Analysis	Frankfurt, Germany
Bad Tolz, Germany	Grafenwohr, Germany
Erding, Germany	Hahn AFB, Germany (Cont'd

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The maximum difference between observed climatology for pairs of closely spaced stations is used to test the hypothesis that the climatology is the same for the pairs and thus climatology at one station could be used to predict climatology at a nearby point. The hypothesis was not proven true in all samples. Ceiling and visibility summaries were used for the test.

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19. KEY WORDS (Cont'd)

Heidelberg, Germany
Hohenfels, Germany
Nurnberg, Germany
Sandhofen, Germany
Wiesbaden, Germany

Preface

USAFETAC Reports 7966 and 8065A described an attempt to model the climatological distribution of an element at a point where no meteorological observations exist in support of Reforger 76. While continuing these efforts to test and provide this type of model, USAFETAC has received some questions. One of those questions is, "Couldn't we do just as well by using a nearby station that has a climatological summary available?" This study is directed toward answering that question.

In the event that this report is incorporated into another report by the requester or any other agency, request that USAFETAC be given proper credit and be furnished a copy of the new report in all cases where such dissemination is not prohibited.

USAFETAC prepared this study to investigate a specific question of spatial climatological variability in a specific geographical area. Therefore, this report does not have wide applicability beyond answering that question. Department of Defense (DOD) agencies and/or their contractors should refer any question on this specific climatological study to USAFETAC for consultation.

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TEST OF A SUGGESTED APPROACH TO SPREADING CLIMATOLOGY TO GRID POINTS

Introduction

A computerized climatology model (CLIMO) program, described [1] and tested [2] by Young, did not provide a satisfactory solution to the problem of "spreading" climatology. Either a new approach or considerably more development and testing of the model is needed. A very logical question arose during development of CLIMO: "Couldn't we do just as well by using a nearby station that has a climatological summary available?" In a way, that is what meteorologists have done for years — using knowledge of the area, experience, and other techniques of estimating climatology at a point where no meteorological observations exist. Spatial and temporal correlation studies have been made for years, but we do not believe that anyone has done any such studies for the resolution required and for the meteorological parameters of concern in the problem at hand — climatological support at any Army combat grid resolution.

USAFETAC prepared this study to answer the question posed above by using available climatological summaries and comparing various meteorological parameters for stations separated by various distances. Either station could be considered the "predictor" or the "grid point." The study is divided into two parts: The first part uses stations as close together as we could find while the second part uses one master station for a much larger area with selected stations over 100 miles from the master station, but with all stations in a specified height range.

Test Procedure

The test was divided into two parts. Test 1 used selected pairs of stations as close together as could be found (10-45 miles). Assuming that the observed frequencies for the stations being compared were the same, we tested the hypothesis using the Kolmogorov-Smirnov two-sample test described by Siegel [3]. Test 2 used a master station to represent an area at a selected elevation range (1000-1600 ft) above mean sea level. The stations to be compared were located in the range of 100-120 miles from the master station. The same statistical test used in Test 1 was

used. Table 1 lists the stations used in the study. Figure 1 shows their locations.

a. Test 1. The first pair of stations that we compared were Wiesbaden/Finthen, approximately 9 miles apart. Figures 2a and 2b show the plot of the cumulative probability of ceiling and visibility, respectively, for 0700L, September. Note, at the 0.01 level, each comparison is significantly different. Figures 2c and 2d are the same type of plot, except at 1600L. For the afternoon plots the difference is not significant at the 0.01 level.

We continued comparing pairs of stations; the next pair being Wiesbaden/Frankfurt, approximately 11 miles apart. Figures 3a and 3b compare ceiling and visibility, respectively, for 0700L, October (the rest of the comparisons in Test 1 will be in October). Note, the 0700L ceiling is not significantly different, while the 0700L visibility is significantly different. Figures 3c and 3d at 1600L indicate just the opposite. The ceiling summaries are significantly different while the visibility summaries are not significantly different. We continued the comparisons in the same manner; the figures are self explanatory. The remaining comparisons are for Heidelberg/Sandhofen (Figures 4a through 4d); Hohenfels/Grafenwohr (Figures 5a through 5d); and Erding/Bad Tolz (Figures 6a through 6d). Note, the last pair, besides being the greatest geographical distance apart, have the largest difference in height above MSL. Tables 2a and 2b are a tabulation of the results of the comparisons.

b. Test 2. This test was to check stations that were greater distances apart than in Test 1. The test was restricted to comparing one master station, Stuttgart, with three other stations selected within a height range of 1000-1600 ft and over 100 miles from it. Hahn, Feucht, and Nurnberg were the stations being compared with the master station. Tables 3a and 3b show the results of the comparison. Figures 7a and 7b are a plot of the 0700L, October ceiling and visibility comparisons. No other figures were plotted for this test.

Comments

The Kolmogorov-Smirnov statistical test used in this study is a test of whether the maximum difference between two cumulative curves is significant or not. Thus, one set of points that differ more than the critical value can reject the hypothesis; and by definition, the curves are not the same. We noted several plots that could have been used but were rejected statistically by the test. Most of

the Reforger [1][2] support scenarios tested involved cloud ceiling values of 500 feet or less and visibility values of 3 miles or less. If we had used the summaries, as suggested by the question posed for this study, we could have used several stations to represent a nearby point (in fact, up to 34 miles away) and not been very much in error. For example, review the following figures which were rejected cases that could have been used for the scenarios of interest: 2a, 3c, 4d, 5a, 5d, and 6d.

Conclusions

Our answer to the question is a very qualified yes; prepared summaries could have been used and we would have done better than the model. However, we must note that just one regular summary not being rejected would be better than the test of the model in which all comparisons were rejected. This study shows there were several cases where prepared summaries sould have worked. Unfortunately, the successes appear to be random or inconsistent which negates the method as a good solution.

Of all the cases checked by the statistics of Test 1, ceiling and visibility, 8 out of 20 would have worked for the "grid points" being tested. For ceiling, 6 out of the 10 would have worked; for visibility, 2 out of the 10 would have worked. If we had ignored some of the rejections, as discussed in the comments section, we may have increased the overall to 14 out of 20. The same philosophy would have made some of the modeled output of the CLIMO test acceptable.

Of all the cases checked in Test 2, both ceiling and visibility, only 9 out of 36 would have worked using the master station. For ceiling, 5 out of 18 could have worked; for visibility, 4 out of 18 would have worked.

The general conclusion remains the same; this "spreading" of climatology is a very complex problem. Further study and development are needed.

References

[1] Young, Murray J.: "Reforger 76 Support," USAFETAC Report 7966, August 1976, 6 p.

[2] Young, Murray J.: "An Independent Test of the Reforger 76 Support CLIMO Program," USAFETAC Report 8065A, (Revised), January 1977, 12 p.

[3] Siegel, Sidney: Nonparametric Statistics, McGraw-Hill Book Co., Inc., New York, 1956, pp. 46-136.

Table 1. Stations Used in the Tests.

Station Pairs (Elev. in Ft abv MSL)	≈ Distance Apart (Miles)
TEST 1	
Wiesbaden (460) - Finthen (761)	9
Wiesbaden (460) - Frankfurt (368)	11
Heidelberg (360) - Sandhofen (334)	14
Grafenwohr (1360) - Hohenfels (1450)	34
Erding (1512) - Bad Tolz (2360)	43
TEST 2	
Stuttgart (1300) - Hahn (1649)	118
Stuttgart (1300) - Feucht (1265)	101
Stuttgart (1300) - Nurnberg (1045)	102

Figure 1. Stations used in the study.

Table 2a. Significance Test - CEILING.

Selected Pairs of Stations	Mon	Hour LST	Critical Value	Sig Dif at 0.01 Level	N_1	N_2
Wiesbaden/ Finthen	Sep	0700	0.0676	Yes	2250	784
		1600	0.0679	No	2250	774
Wiesbaden/ Frankfurt	Oct	0700	0.0478	No	2324	2324
		1600	0.0478	Yes	2324	2319
Heidelberg/ Sandhofen*	Oct	0700	0.0644	No	1933	960
		1600	0.0643	No	1923	965
Hohenfels/ Grafenwohr*	Oct	0700	0.0750	Yes	860	1045
		1600	0.0758	No	837	1032
Erding/ Bad Tolz	Oct	0700	0.0847	Yes	1115	554
		1600	0.0841	No	1115	567

Table 2b. Significance Test - VISIBILITY.

Selected Pairs of Stations	Mon	Hour LST	Critical Value	Sig Dif at 0.01 Level	N_1	N_2
Wiesbaden/ Finthen	Sep	0700	0.0676	Yes	2250	784
		1600	0.0679	No	2250	774
Wiesbaden/ Frankfurt	Oct	0700	0.0478	Yes	2324	2324
		1600	0.0478	No	2324	2319
Heidelberg/ Sandhofen*	Oct	0700	0.0644	Yes	1933	960
		1600	0.0643	Yes	1923	965
Hohenfels/ Grafenwohr*	Oct	0700	0.0750	Yes	860	1045
		1600	0.0758	Yes	837	1032
Erding/ Bad Tolz	Oct	0700	0.0847	Yes	1115	554
		1600	0.0841	Yes	1115	567

* Station used to test CLIMO as described in Report 8065A (Revised) [2].

Table 3a. Significance Test Using Stuttgart as the Master Station - CEILING.

Station	Mon	Hour LST	Critical Value	Sig Dif at 0.01 Level	N_1	N_2
Hahn	Sep	0700	0.0542	Yes	2128	1577
		1600	0.0542	Yes	2125	1577
Feucht	Sep	0700	0.0854	No	2128	439
		1600	0.0881	No	2125	408
Nurnberg	Sep	0700	0.0557	Yes	2128	1432
		1600	0.0559	No	2125	1414
Hahn	Sep	0700	0.0523	Yes	2319	1671
		1600	0.0523	Yes	2316	1673
Feucht	Sep	0700	0.0847	Yes	2319	441
		1600	0.0841	No	2316	449
Nurnberg	Sep	0700	0.0543	Yes	2319	1478
		1600	0.0543	No	2316	1475
Hahn	Nov	0700	0.0531	Yes	2246	1620
		1600	0.0532	Yes	2248	1616
Feucht	Nov	0700	0.0918	Yes	2246	367
		1600	0.0924	Yes	2248	361
Nurnberg	Nov	0700	0.0551	Yes	2246	1438
		1600	0.0551	Yes	2248	1433

Table 3b. Significance Test Using Stuttgart as the Master Station - VISIBILITY.

Station	Mon	Hour LST	Critical Value	Sig Dif at 0.01 Level	N_1	N_2
Hahn	Sep	0700	0.0542	No	2128	1577
		1600	0.0542	Yes	2125	1577
Feucht	Sep	0700	0.0854	Yes	2128	439
		1600	0.0881	No	2125	408
Nurnberg	Sep	0700	0.0557	Yes	2128	1432
		1600	0.0559	No	2125	1414
Hahn	Oct	0700	0.0523	Yes	2319	1671
		1600	0.0523	Yes	2316	1673
Feucht	Oct	0700	0.0847	Yes	2319	441
		1600	0.0841	Yes	2316	449
Nurnberg	Oct	0700	0.0543	Yes	2319	1478
		1600	0.0543	Yes	2316	1475
Hahn	Nov	0700	0.0531	Yes	2246	1620
		1600	0.0532	Yes	2248	1616
Feucht	Nov	0700	0.0918	No	2246	367
		1600	0.0924	Yes	2248	361
Nurnberg	Nov	0700	0.0551	Yes	2246	1438
		1600	0.0551	Yes	2248	1433

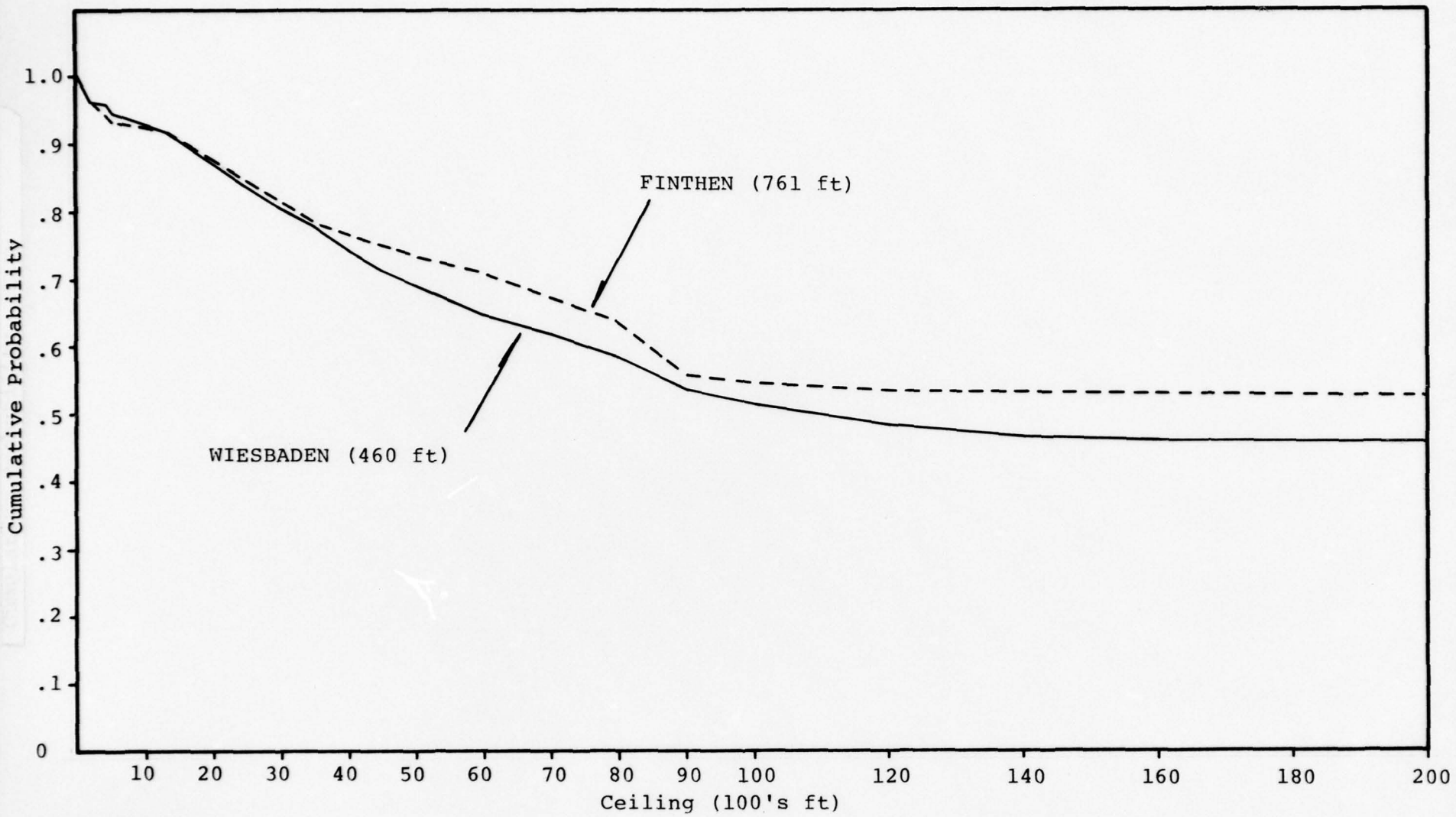
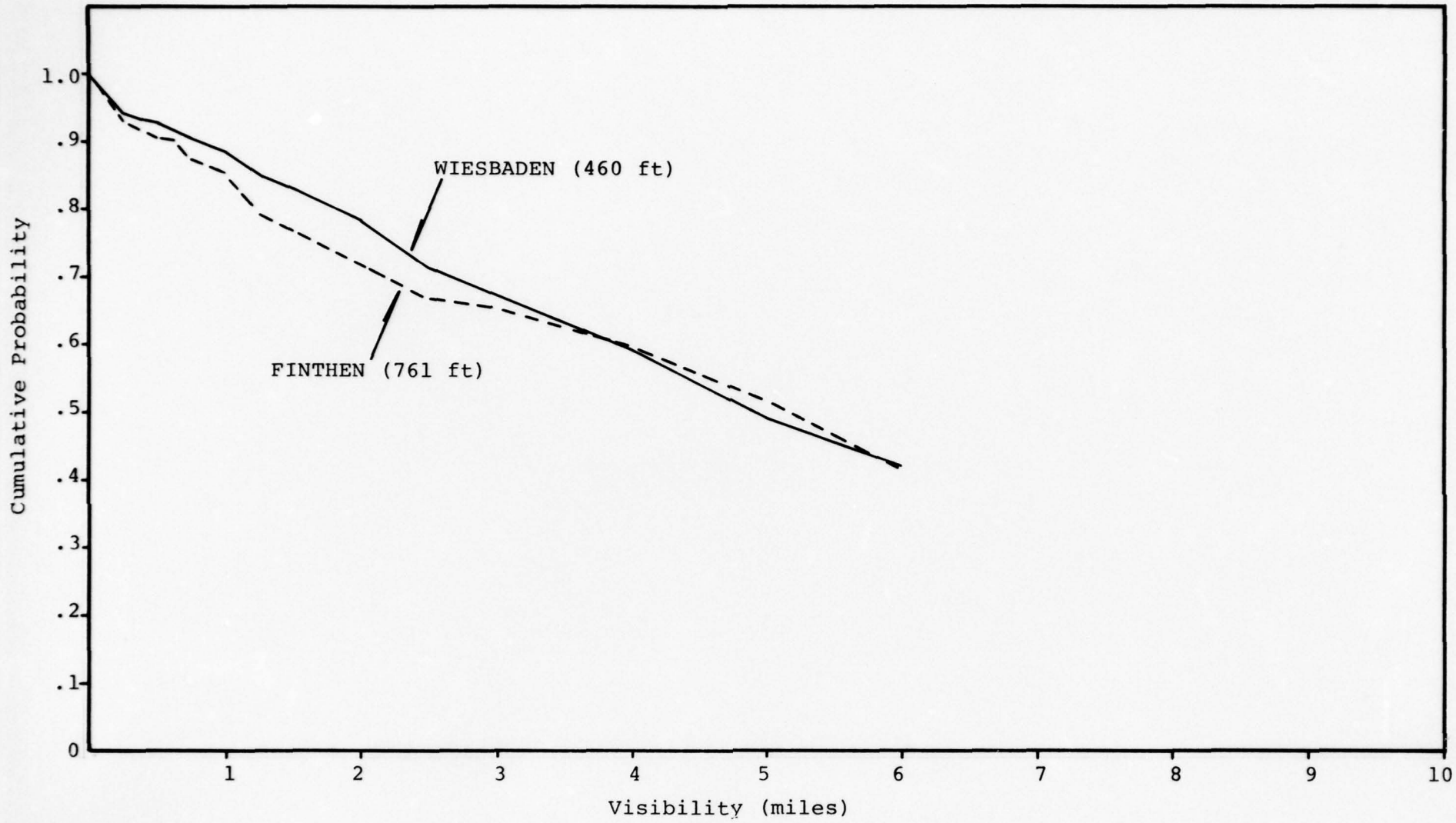


Figure 2a. Wiesbaden/Finthen Ceiling Comparison 0700L September
Significantly Different at 0.01 Level (approximately 9 miles apart)



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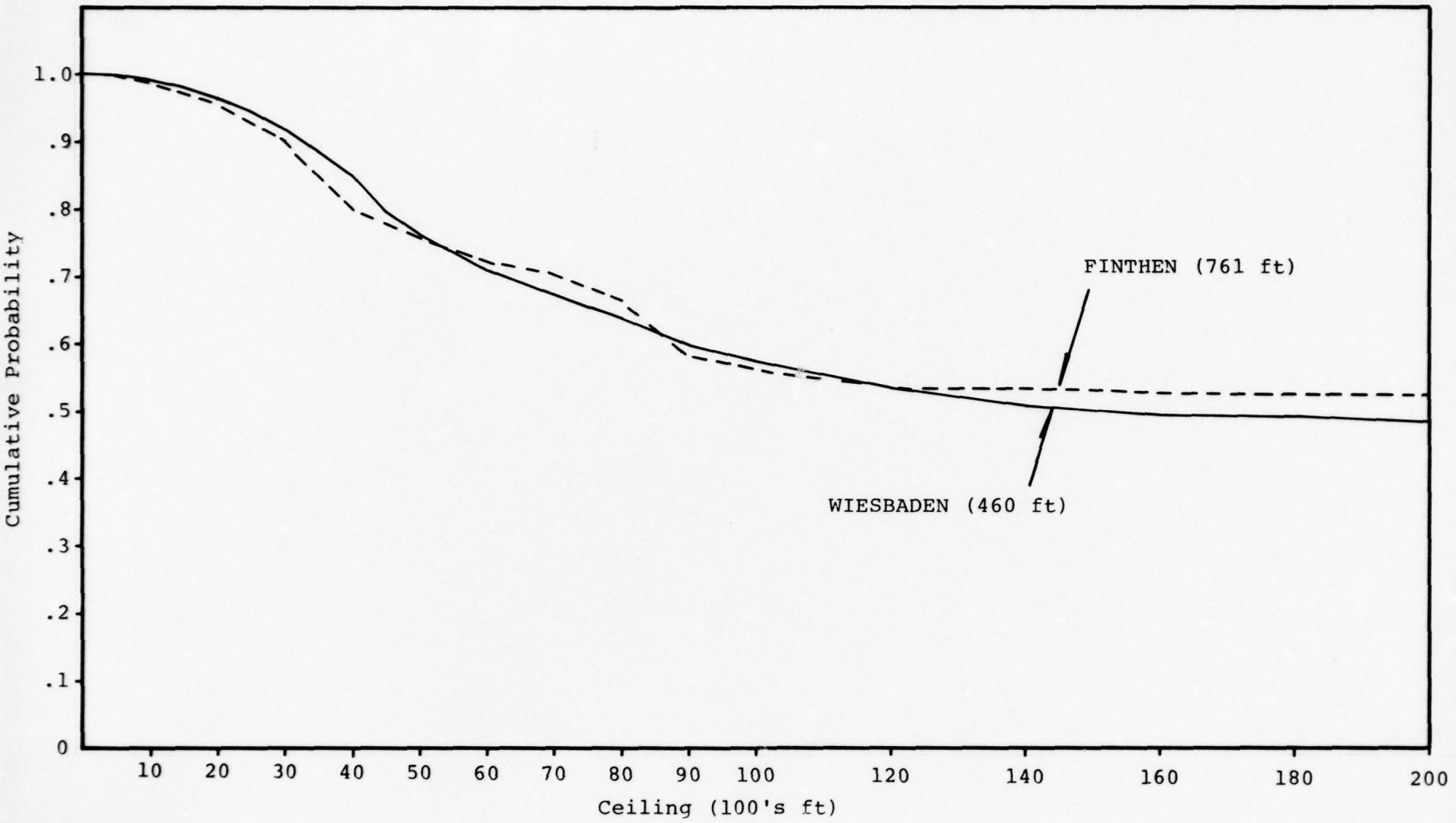

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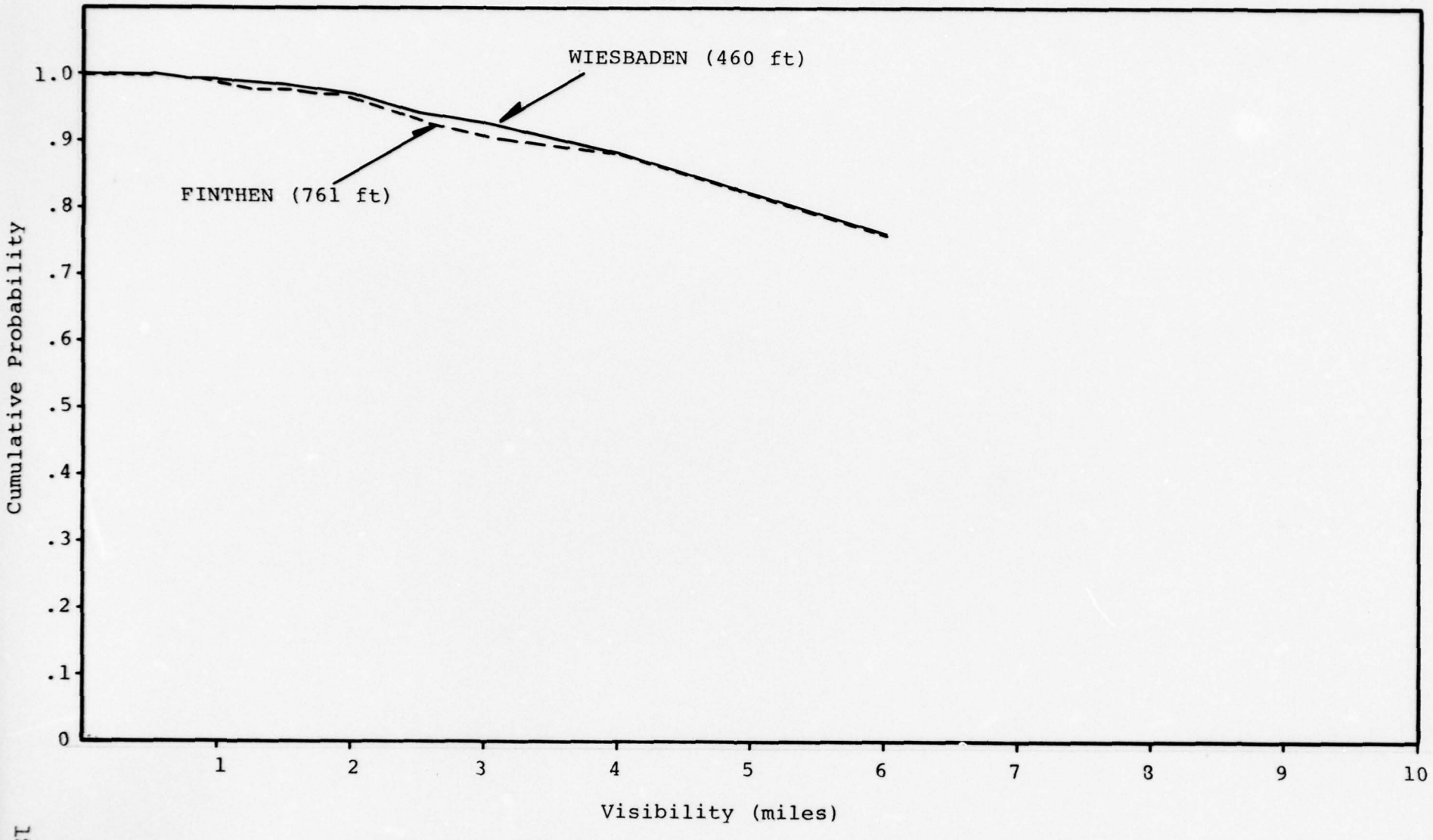

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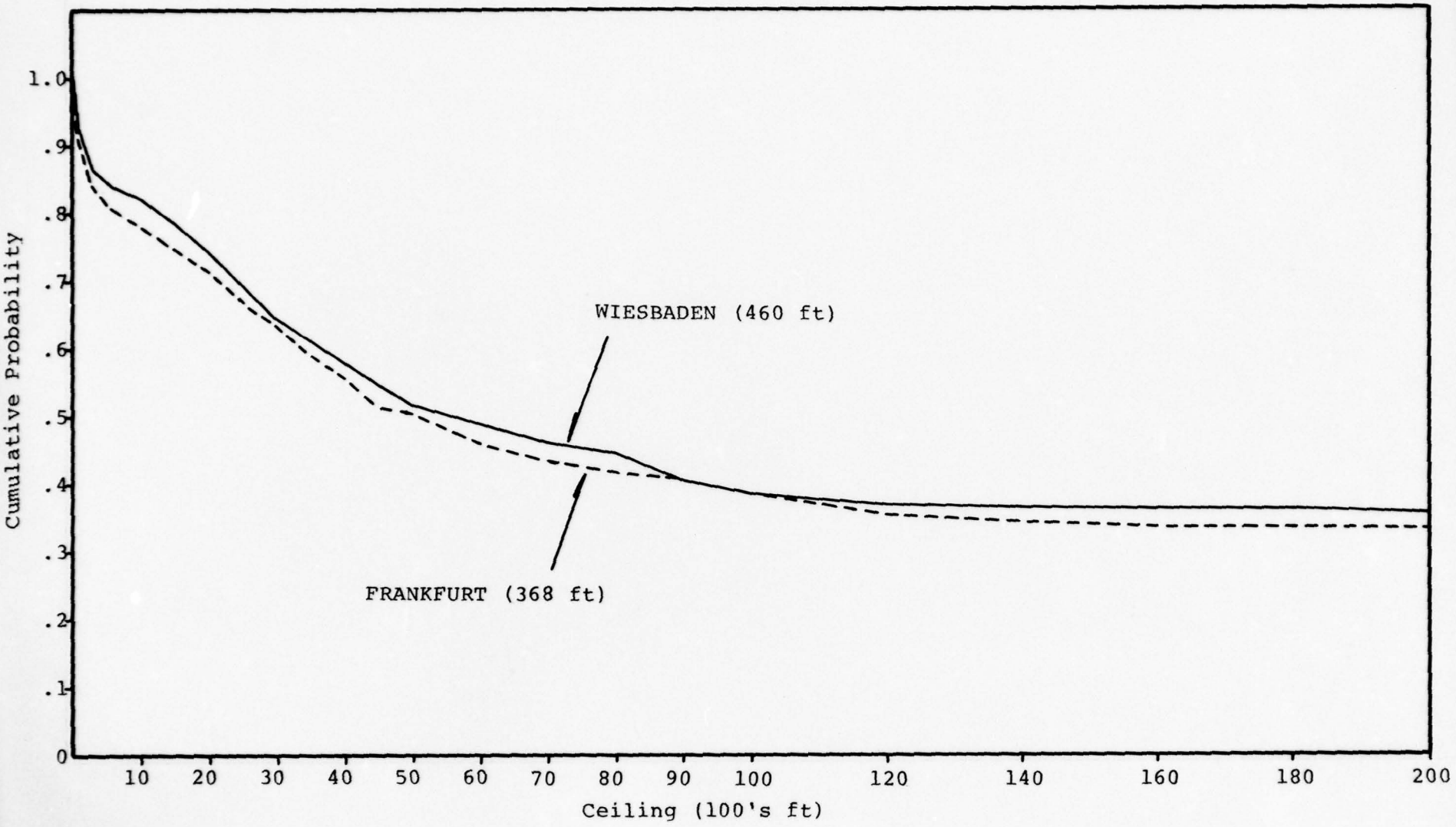
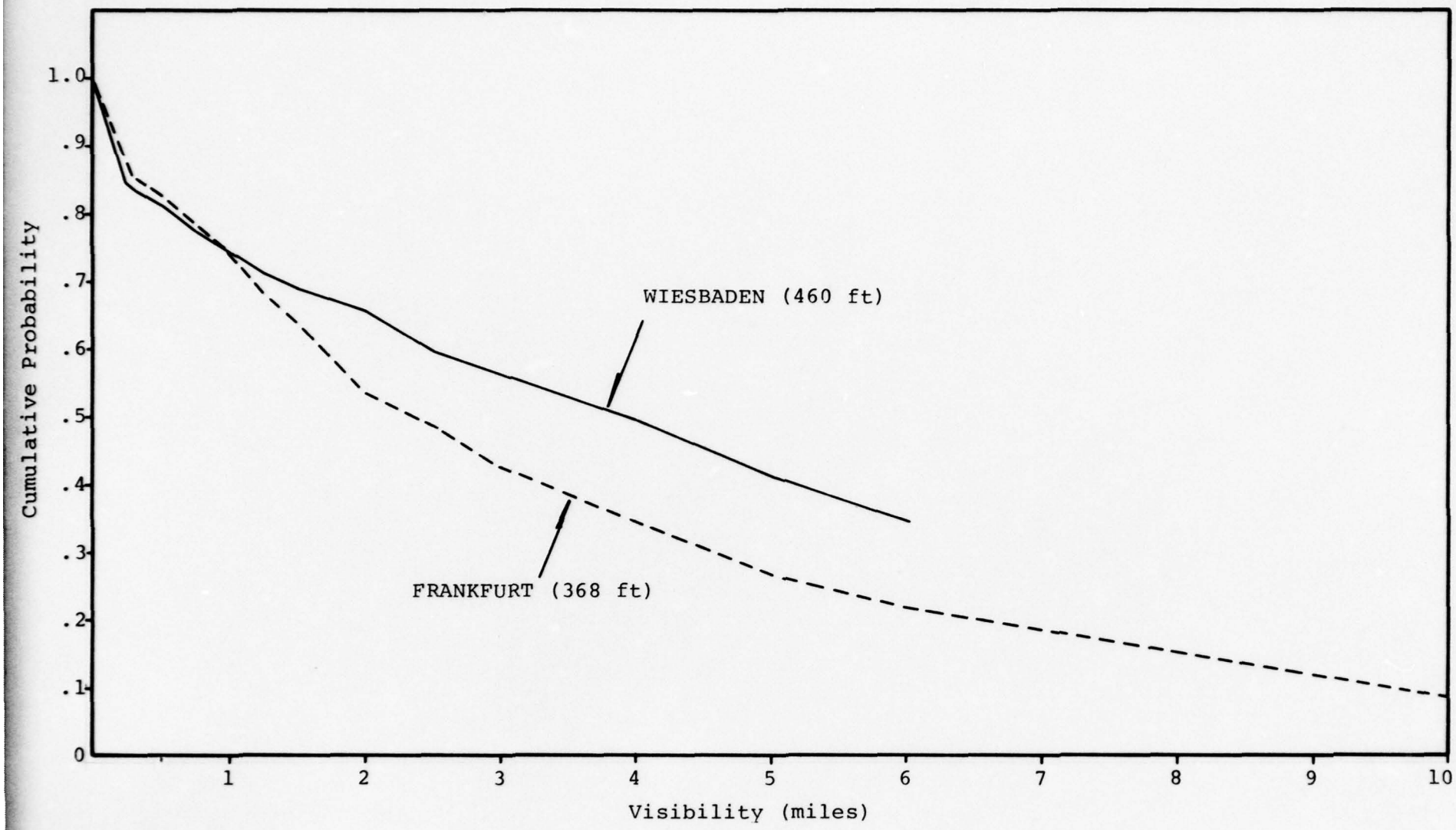


Figure 3a. Wiesbaden/Frankfurt Ceiling Comparison 0700L October Not Significantly Different at 0.01 Level (approximately 11 miles apart)



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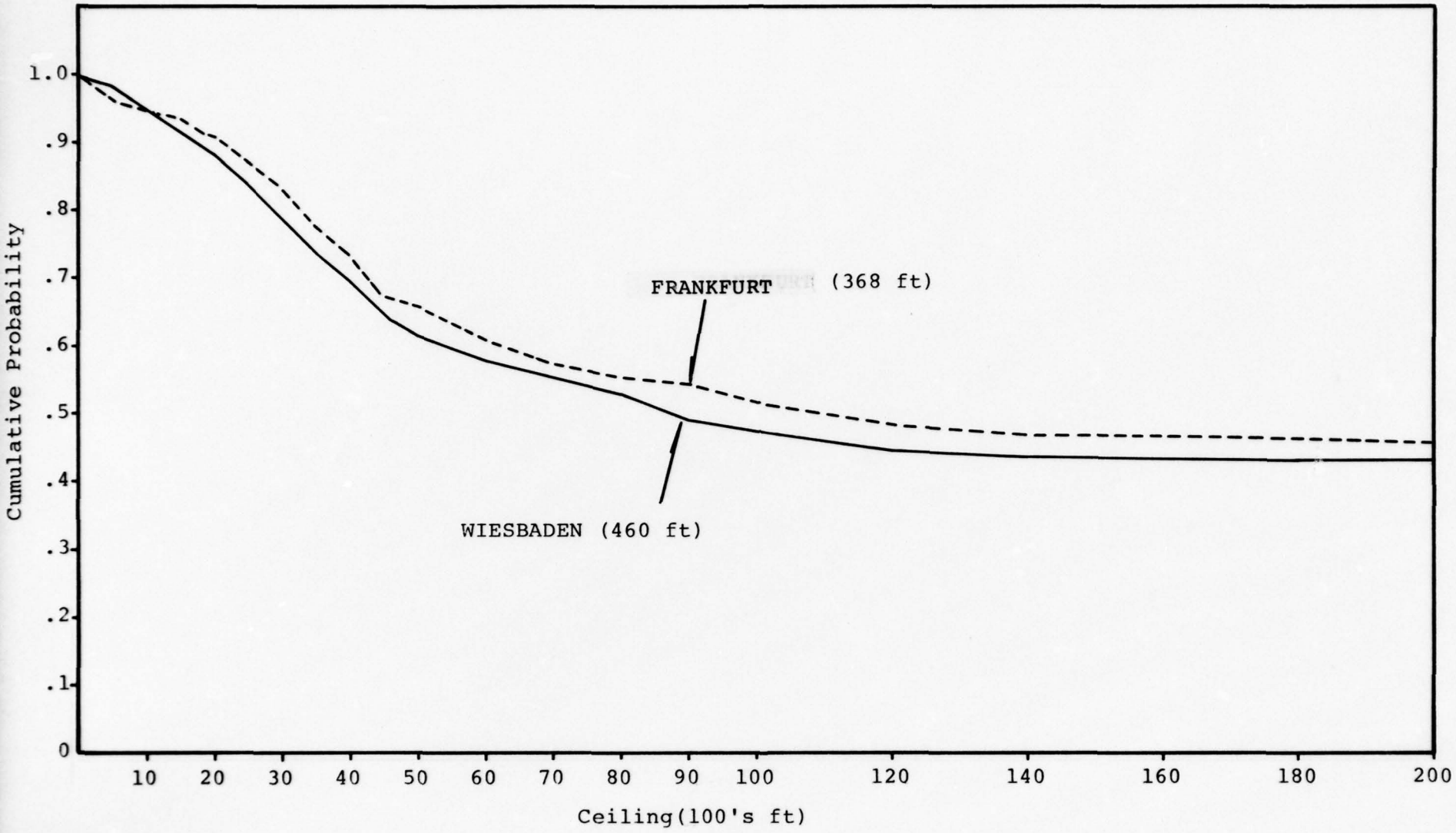

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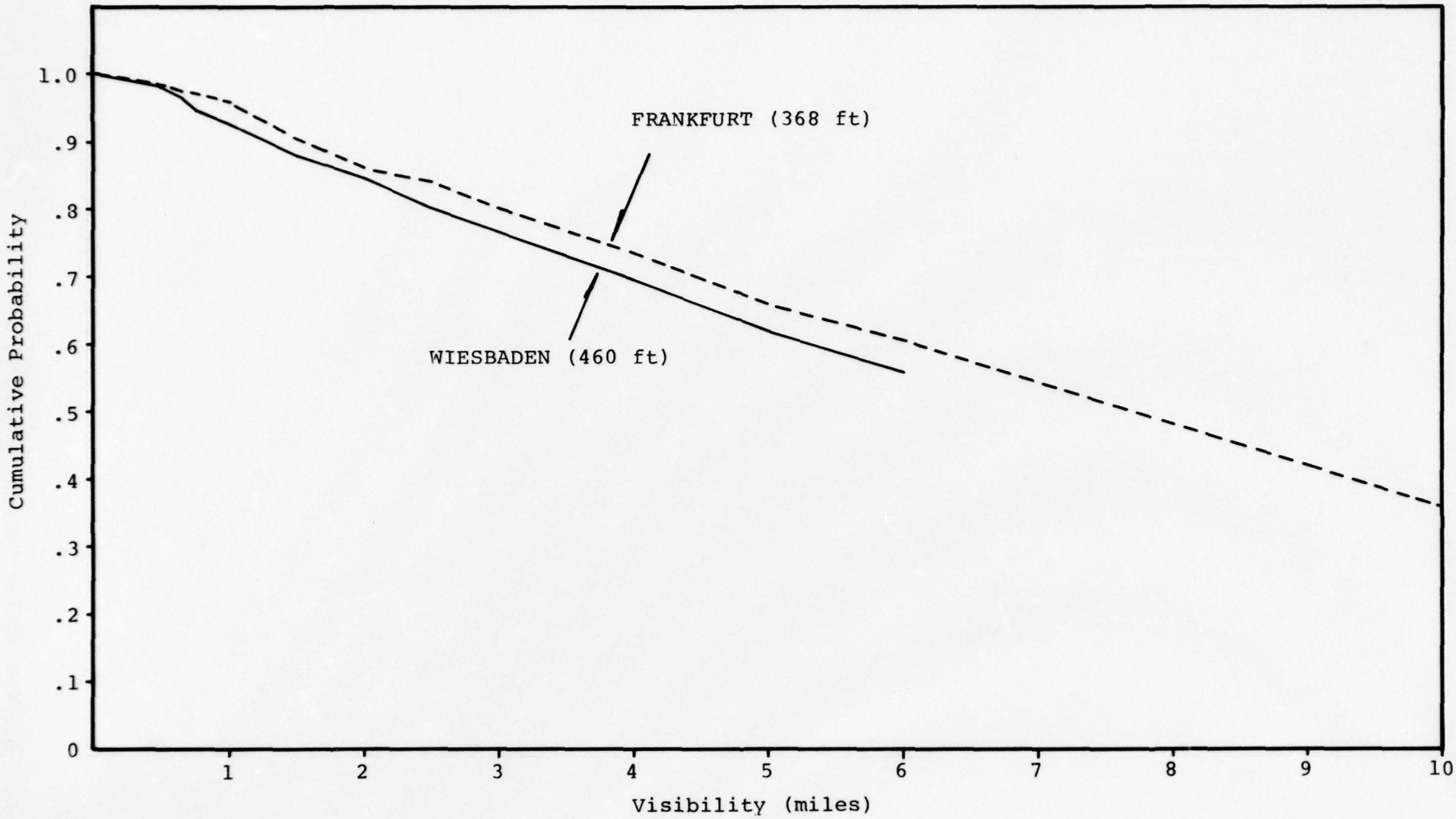

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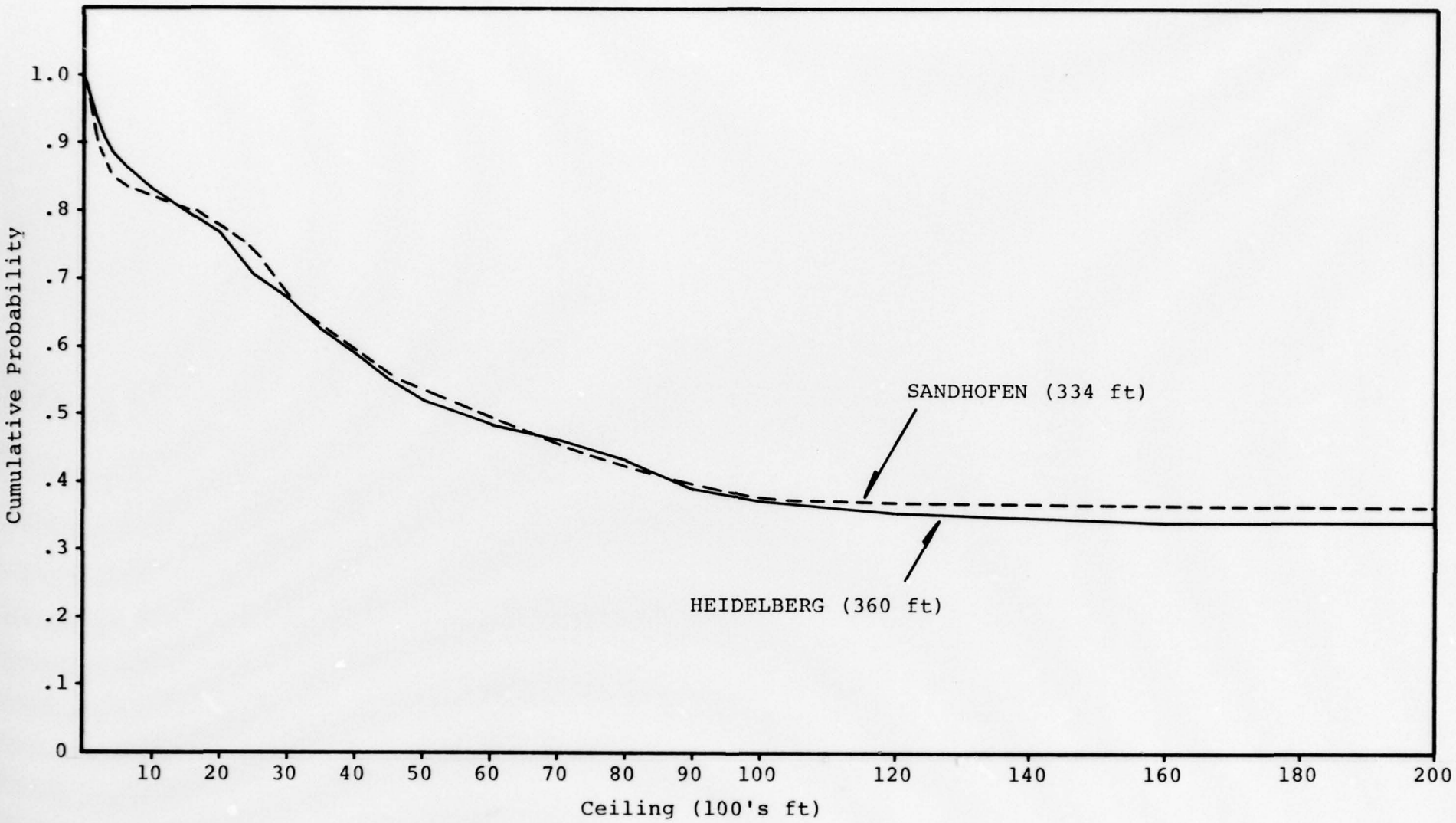
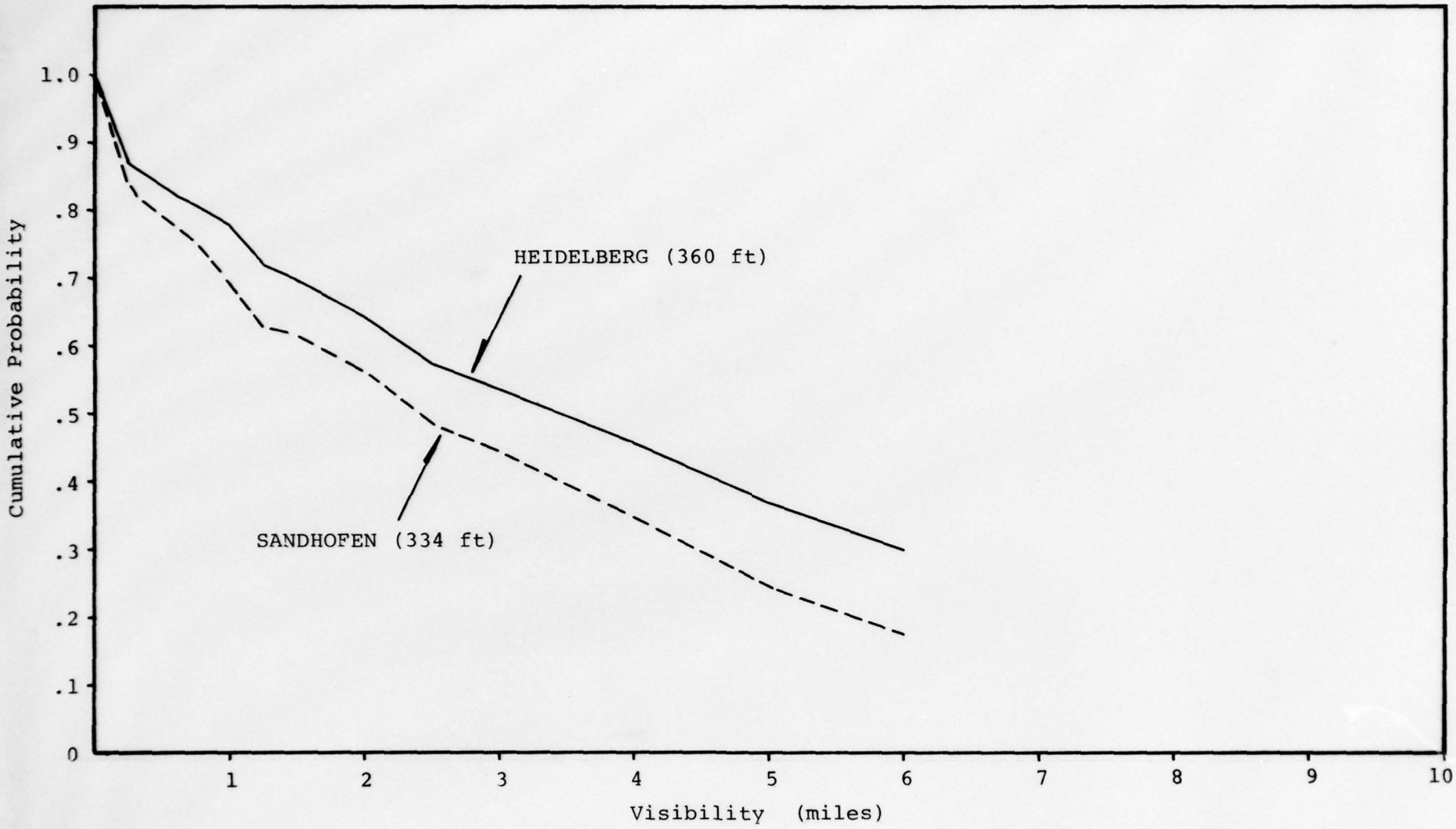


Figure 4a. Heidelberg/Sandhofen Ceiling Comparison 0700L October Not Significantly Different at 0.01 Level (approximately 14 miles)



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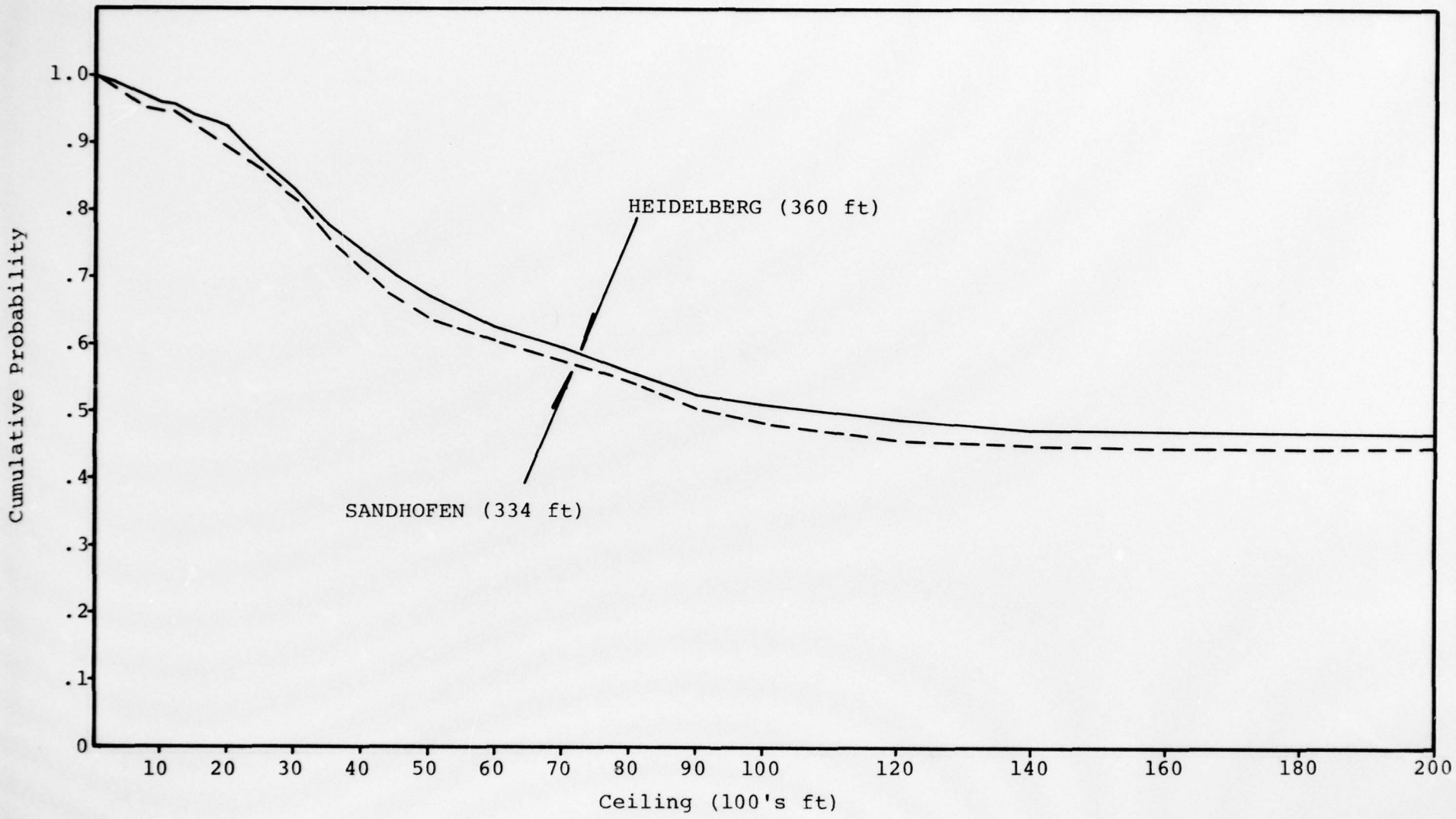

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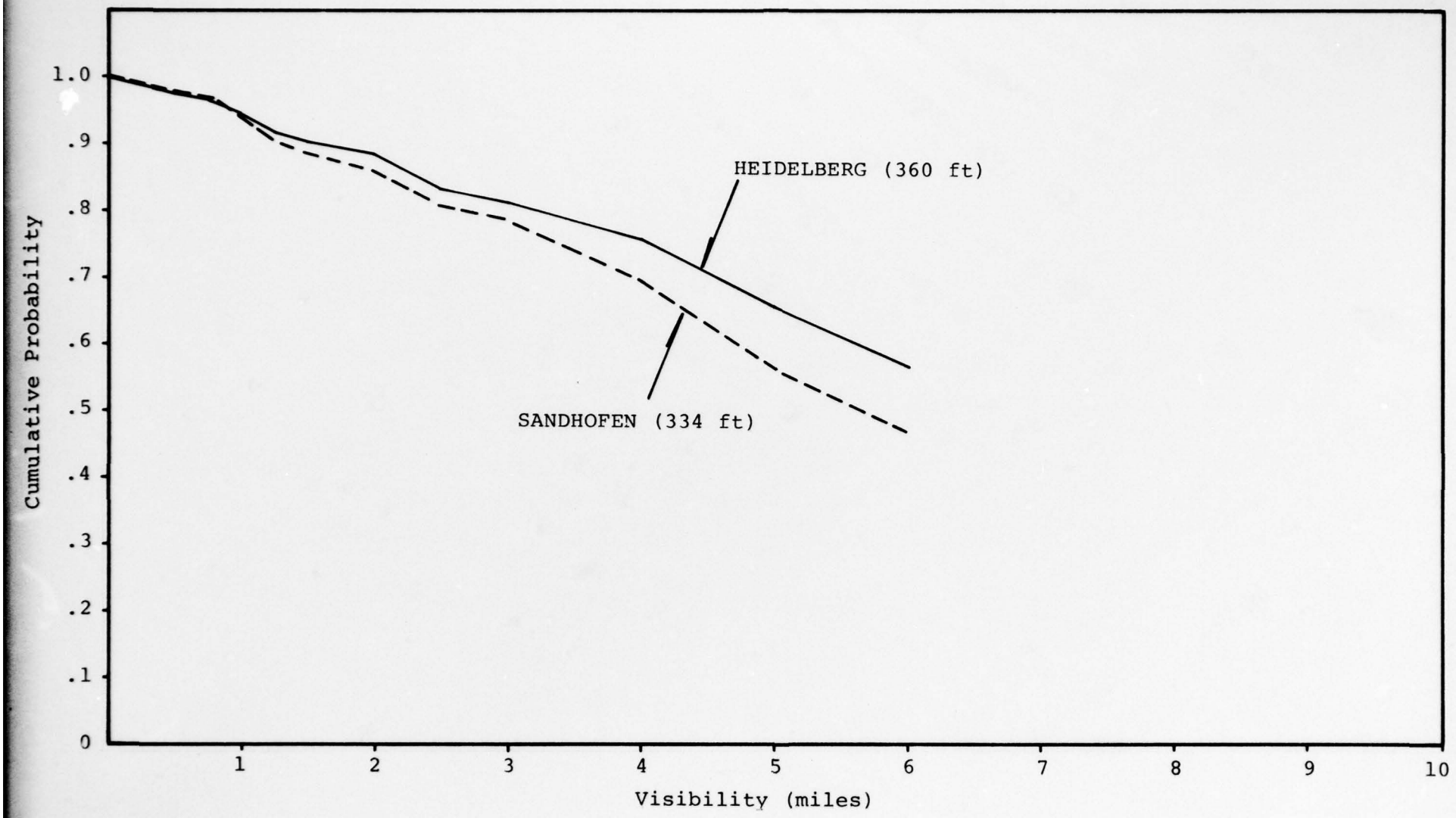

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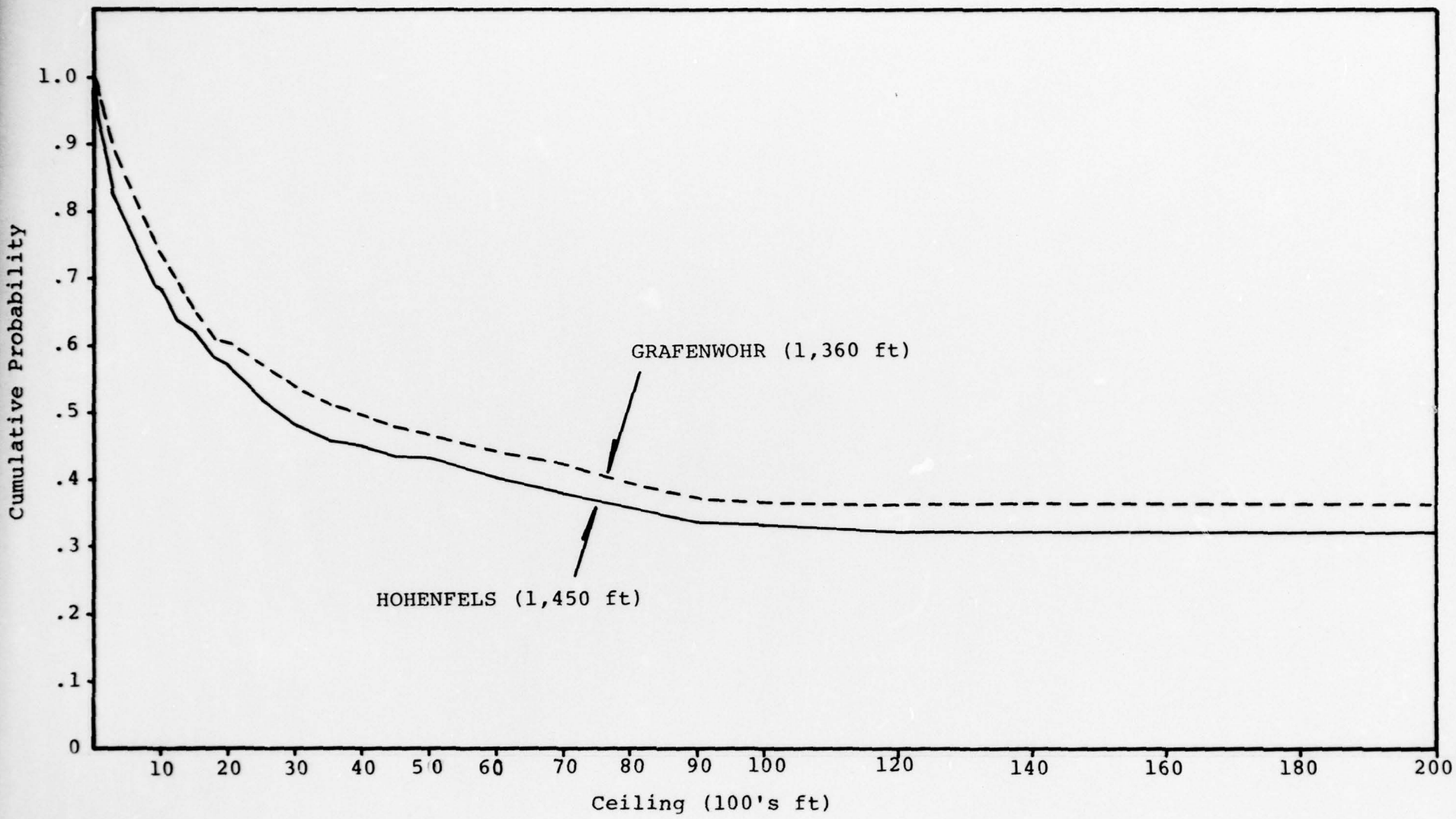
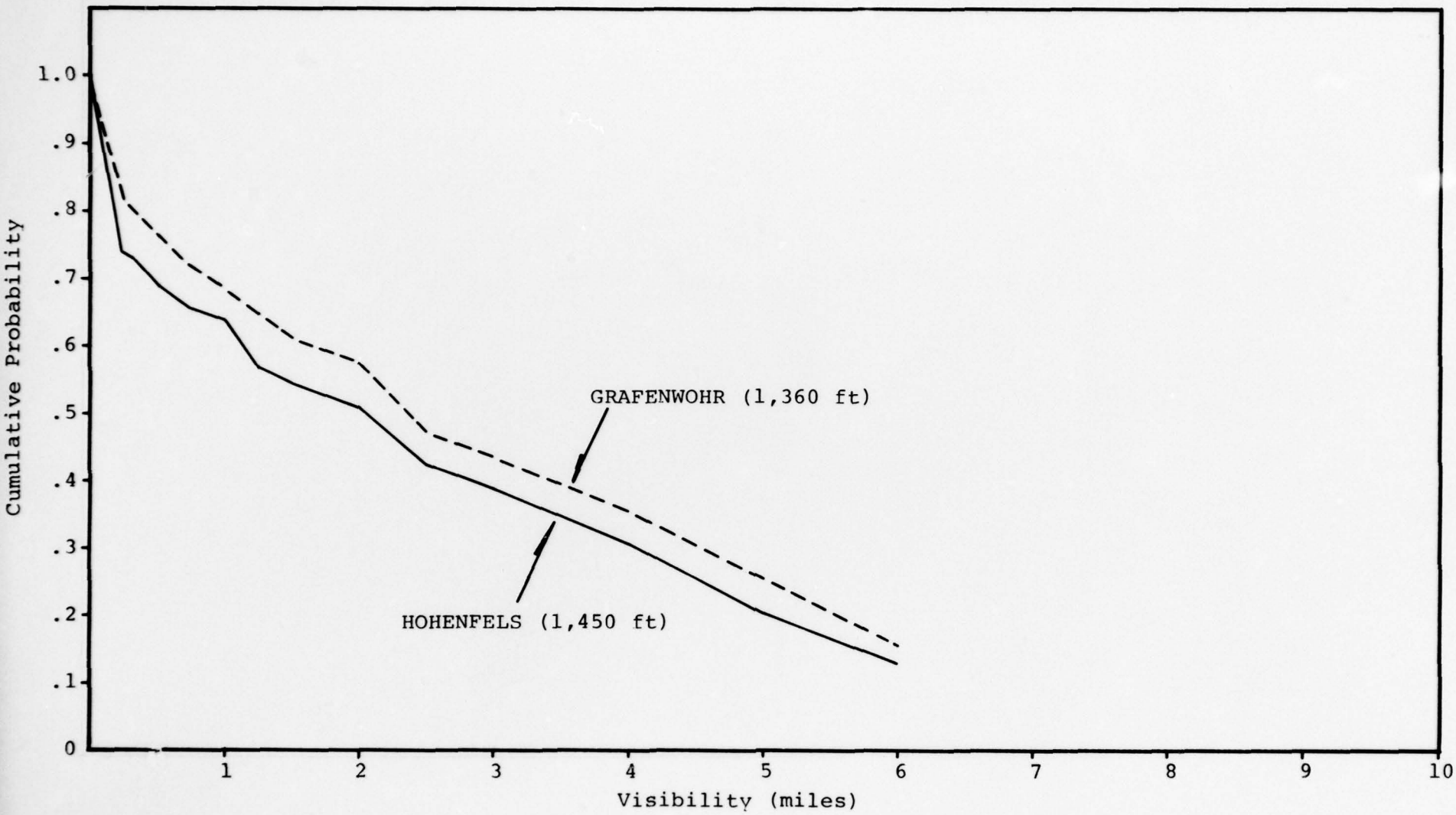


Figure 5a. Hohenfels/Grafenwohr Ceiling Comparison 0700L October Significantly Different at 0.01 Level (approximately 34 miles)



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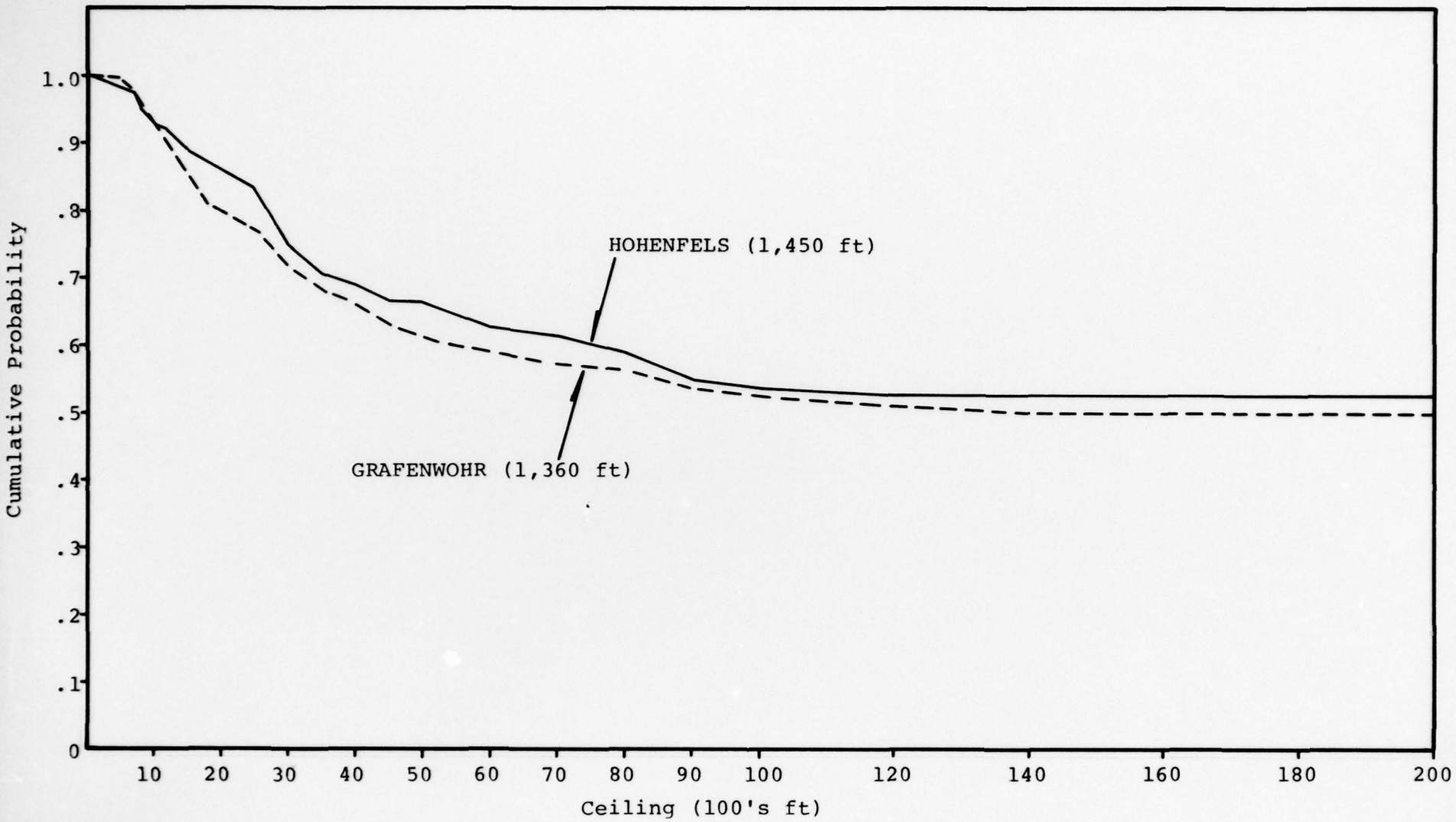

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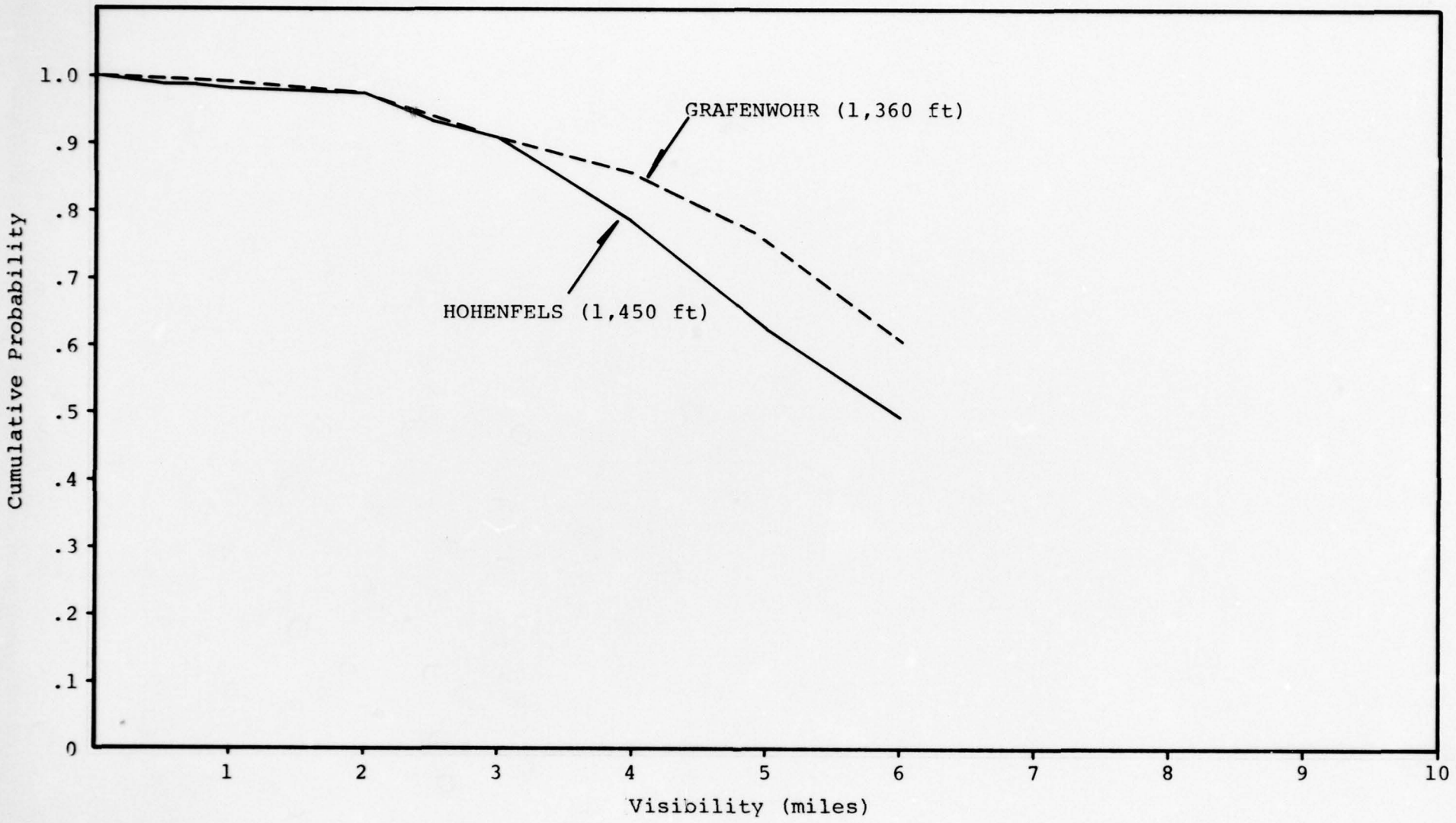

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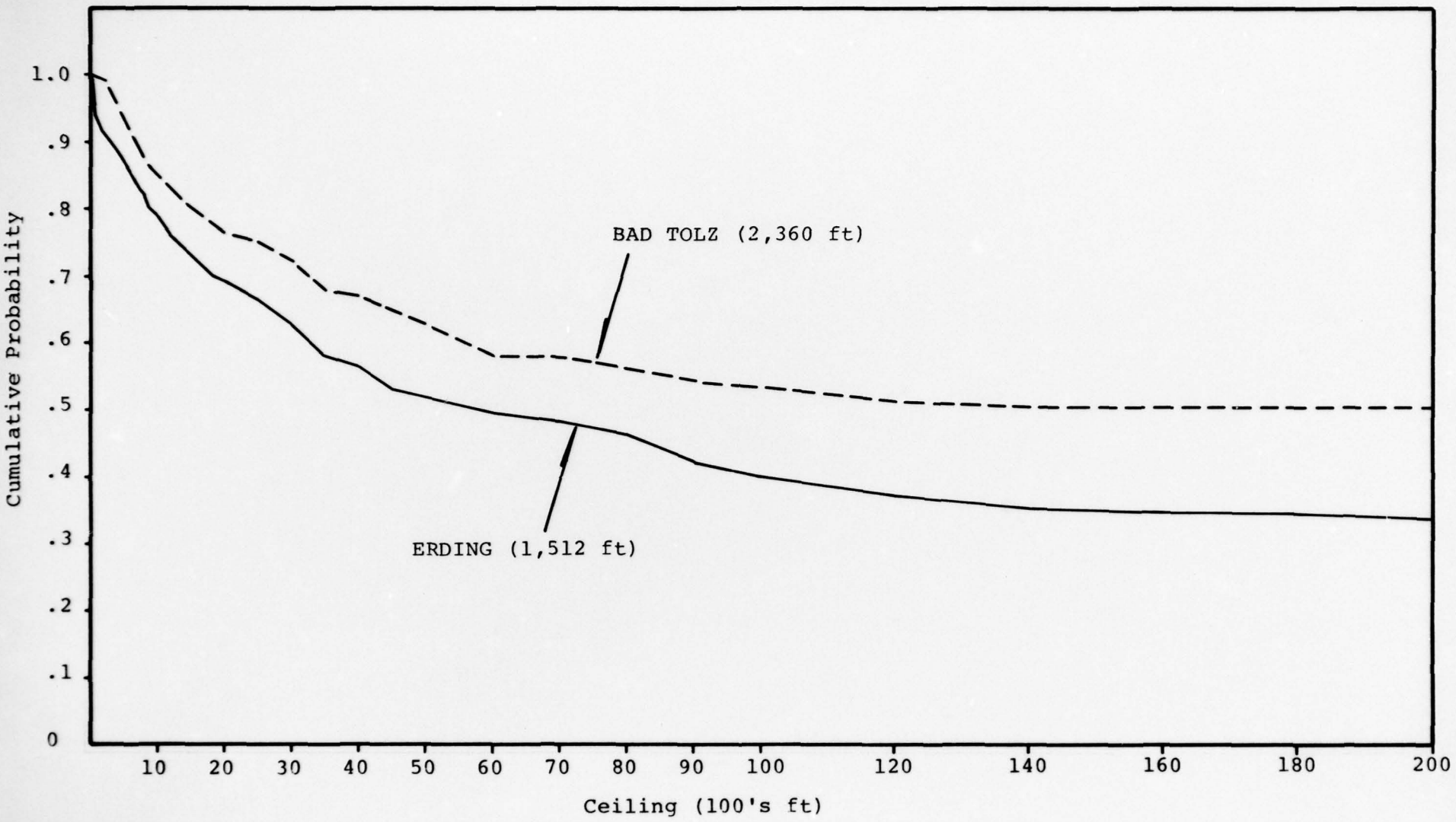

Figure 6a. Erding/Bad Tolz Ceiling Comparison 0700L October
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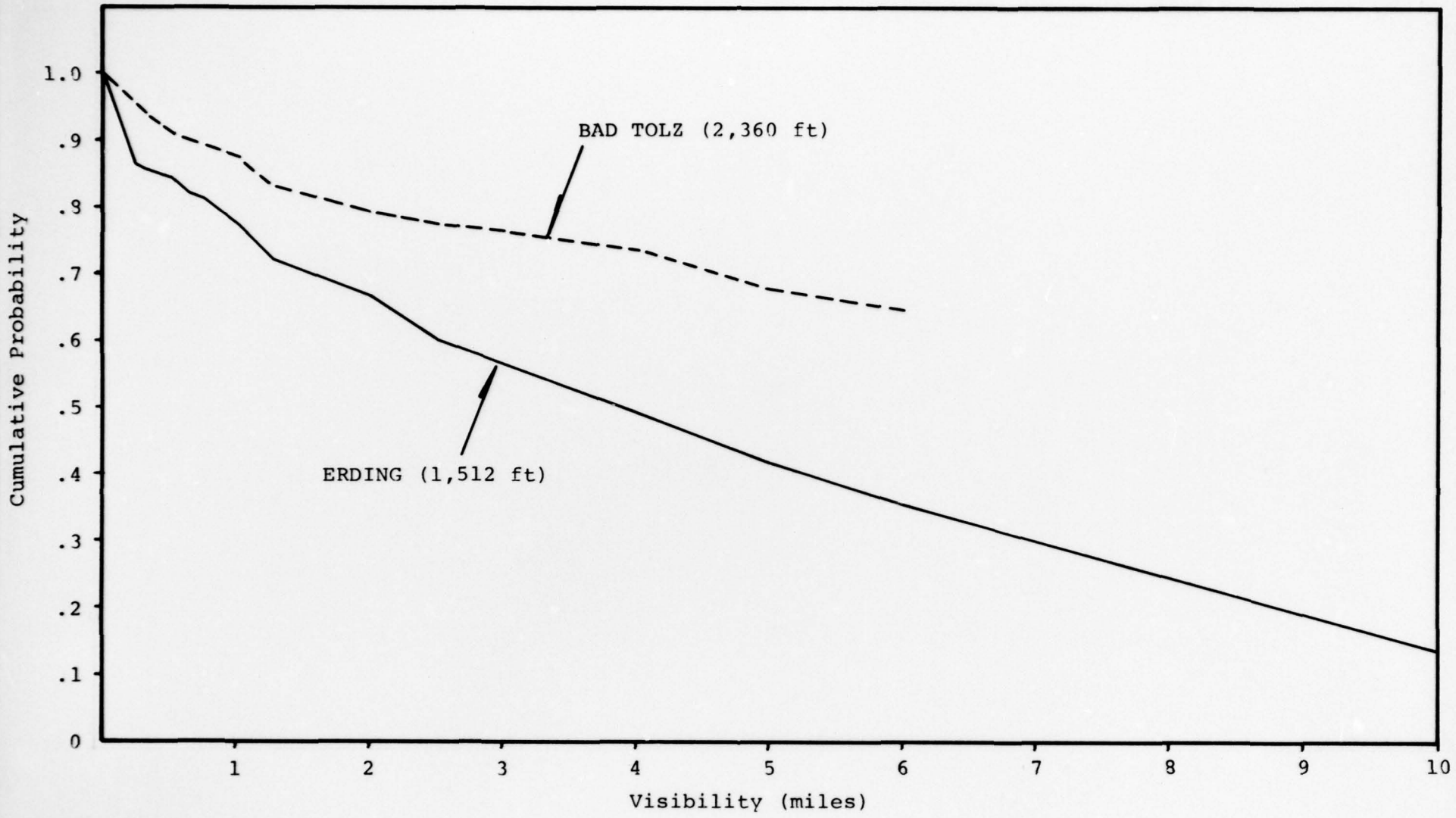

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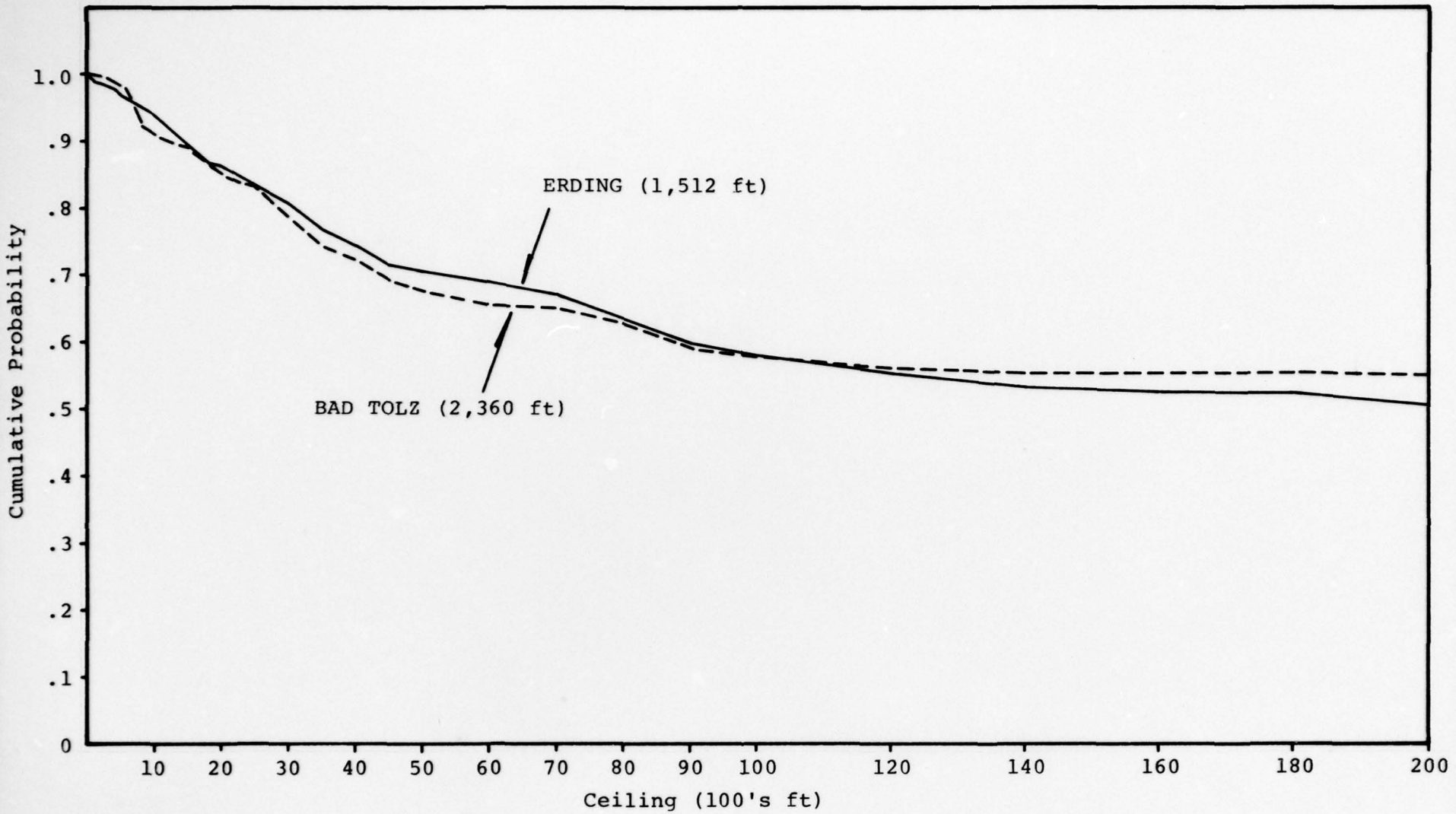

Figure 6c. Erding/Bad Tolz Ceiling Comparison 1600L October Not Significantly Different at 0.01 Level (approximately 43 miles)

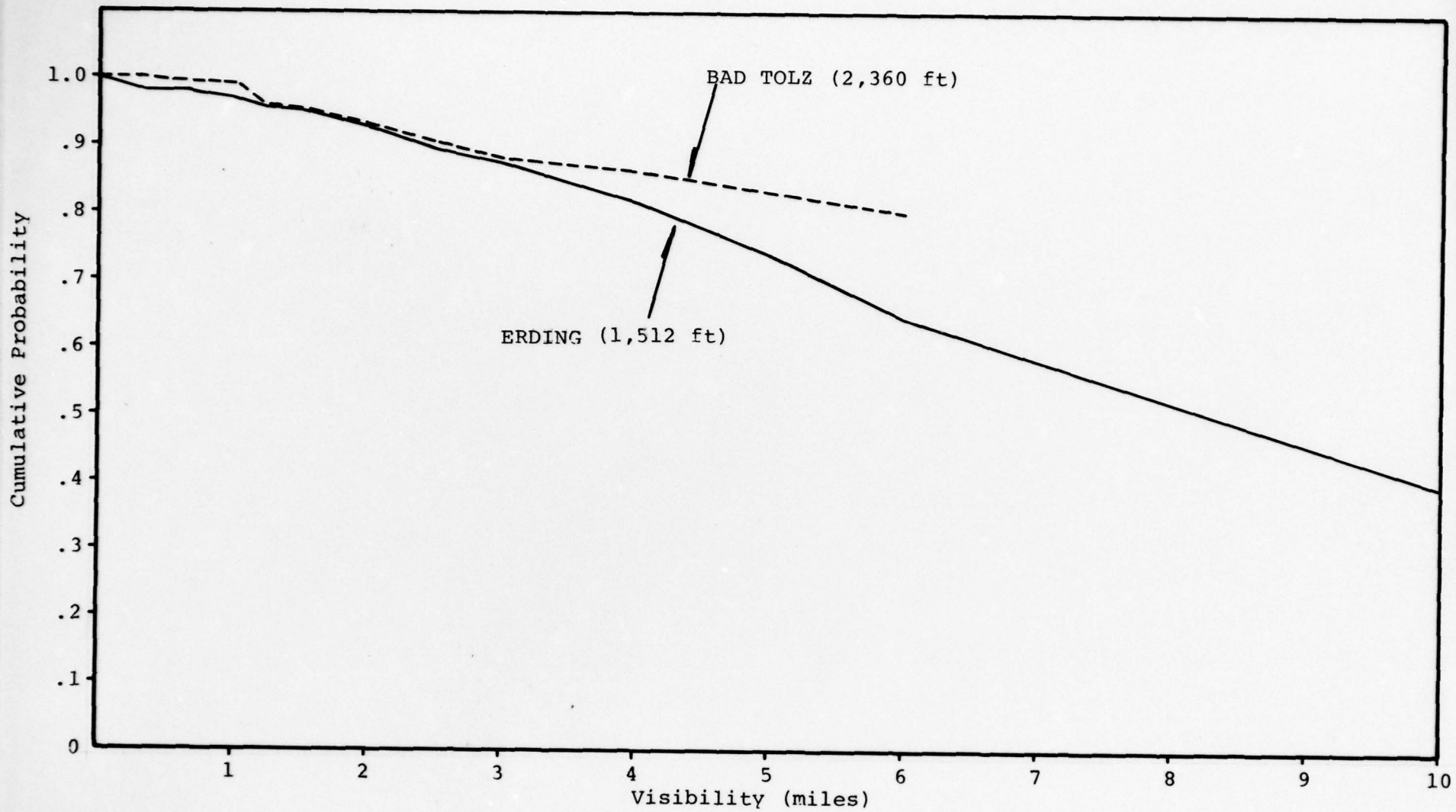

Figure 6d. Erding/Bad Tolz Visibility Comparison 1600L October Significantly Different at 0.01 Level (approximately 43 miles)

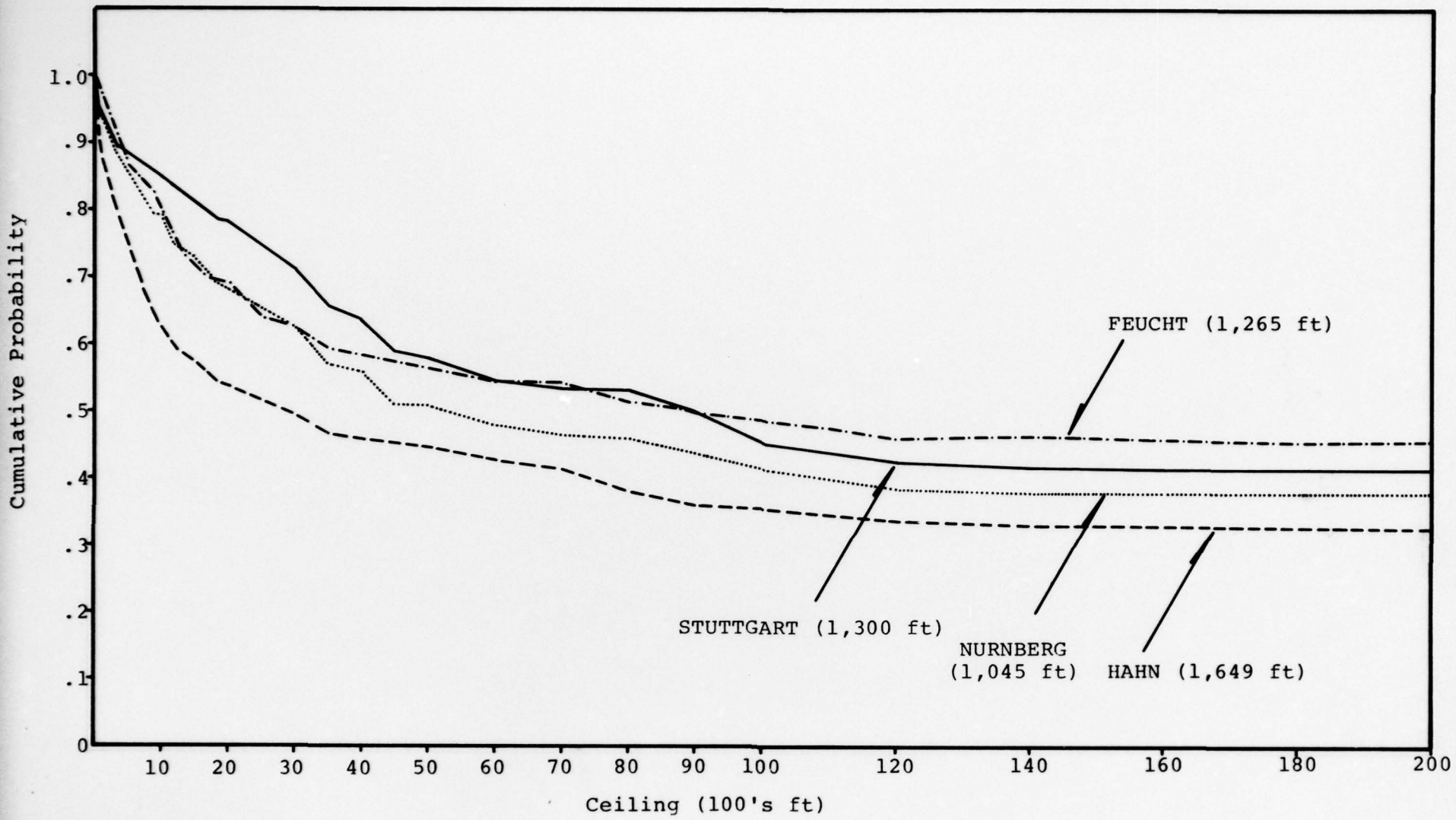

Figure 7a. Ceiling Comparison 0700L October. All Are Significantly Different From Stuttgart at 0.01 Level

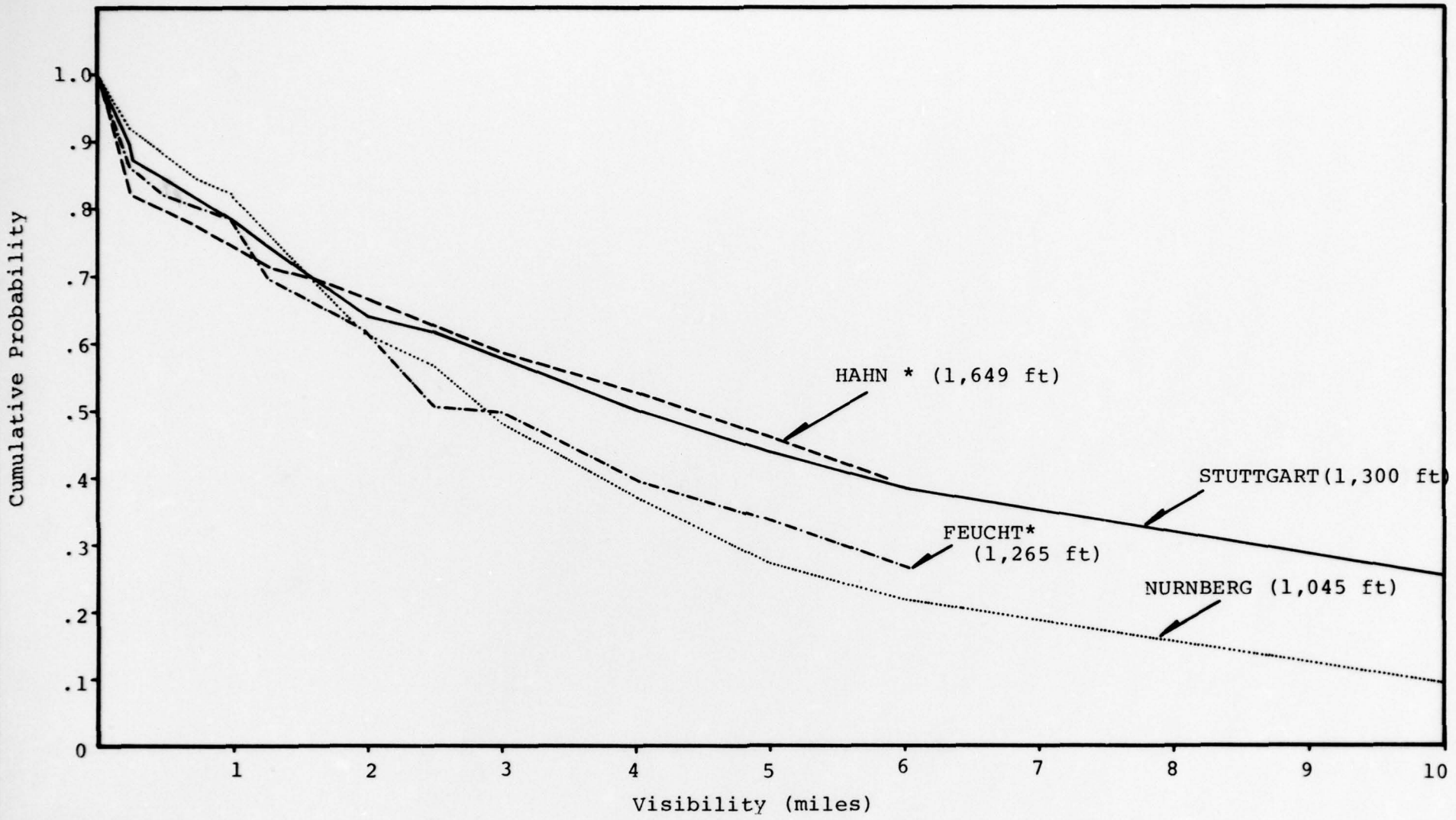

Figure 7b. Visibility Comparison 0700L October
All Are Significantly Different From Stuttgart at 0.01 Level

*Summary stopped at approximately 6 miles