



Atmospheric Propagation Characteristics of  
Electromagnetic Waves in the Short Millimetre Range

Research Contract Serial Number OSU77-00056

Final Report

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For: Department of Communications

Communication Research Centre, Ottawa

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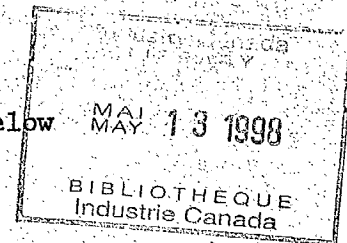
DEPARTMENT OF ELECTRICAL ENGINEERING  
FACULTY OF APPLIED SCIENCE  
THE UNIVERSITY OF BRITISH COLUMBIA

## SUMMARY

The work done under this contract includes:

- (1) Enlarging the data base
- (2) Changes and improvement in the data-acquisition system
- (3) Improvement in the weather-monitoring system
- (4) Construction of drop-size measuring apparatus

Details and progress on these items are given below



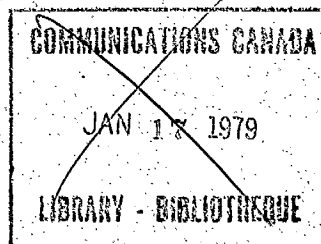
(1) Data-base:

Addition to the existing data base has not been as much as anticipated. Only about 100 hours of useful data have been recorded. The weather during the last six months has not been typical of this location and (consequently?) weather forecasting has been most unreliable. Some "interesting" storms have been recorded, however. Examples of the "reduced" data obtained are given in Figs. 1(a) to 1(i). The experimental values are compared with theory based on various drop-size distributions, at a temperature of 20°C.\*

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Computations are done by R. Olsen of the Communications Research Centre.



(2) Data Acquisition and Processing:

(a) Change to SUPERNOVA Minicomputer:

Our minicomputer data acquisition system was originally prototyped on a Data General NOVA 840 with disk drive and magnetic tape peripherals. The software operated under the Nova Real Time Disk Operating System (RDOS). The NOVA 840 is considered the main minicomputer facility in the department and therefore could not be dedicated to this project. For this reason, the data-acquisition software has now been modified to operate in a SUPERNOVA machine with only a tape drive, under the Nova paper-tape based, core resident, Real Time Operating System (RTOS).

The SUPERNOVA currently has only 16k of memory. This has necessitated a reduction in the data queue length, resulting in less accurate rain-rate measurement at low rain rates because of insufficient integration time.

(b) Data Management System:

The IBM 370 data management software is in the process of being totally rewritten and expanded. The programs which formatted and stored the data on Computer Centre tapes have been rewritten in order to accommodate the larger data records which will be required when rain drop-size data is added. These programs have also been made considerably more flexible (to make future modifications easier), more efficient (in terms of operator input and machine time) and more reliable (in that a much greater

variety of minor errors can be handled without program failure).

Work is now proceeding on data retrieval and manipulation software so that large quantities of recorded data may be processed and analyzed.

(3) Improvement in Weather-Monitoring System:

(a) New Tipping-Bucket Rain Gauges:

The prototype tipping-bucket rain gauge used previously was designed to have a variable tip size. At small tip sizes, it was found that some water clung to the bucket after it tipped, producing a significant measurement error. The rain gauge was therefore redesigned and five new instruments have been constructed. The new model has an improved bucket geometry which reduced bucket water retention. A photograph of the new instrument is shown in Fig. 2.

(b) Wind Velocity Measurement

The apparatus for wind velocity measurement has been relocated at the top of an 8m tower on the top of the Hector McLeod Building. This was done in order to minimize any measurement error (especially in the vertical component) due to turbulences around the 'side' of the building where the instrument was originally located.

(4) Rain Drop-Size Apparatus:

(a) The System:

The design objective was to construct a system which could derive a real time rain drop-size frequency histogram. Sixteen size classes and a one second counting period were considered a reasonable combination to be added to the present data acquisition apparatus.

The basic system includes a rain drop-size transducer, RCA 1802 microprocessor, 12-bit analog to digital converter and NOVA minicomputer interface, as shown in Fig. 3.

The microcomputer converts the analog output from the transducer to a 12-bit digital word and, on this basis, sort the drops according to size, count the number of drops in each size category and once per second format and output the frequency histogram to the NOVA minicomputer for recording on magnetic tape.

The microprocessor has been wired and tested. It must now be interfaced to the A/D converter and the Nova minicomputer.

The software for the microcomputer is yet to be developed and changes in the minicomputer software are to be made in order to accommodate the additional control functions and data acquisition.

(b) The Transducer:

The two approaches considered are electromechanical and electrostatic. The former relies on converting the impact of the drop as it hits a surface to an electrical signal, while the latter works on the principle that the charge a drop picks up as it passes through a charged grid is proportional to its diameter.

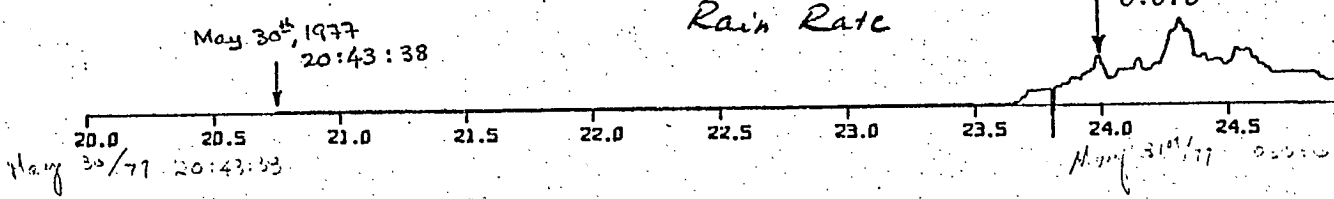
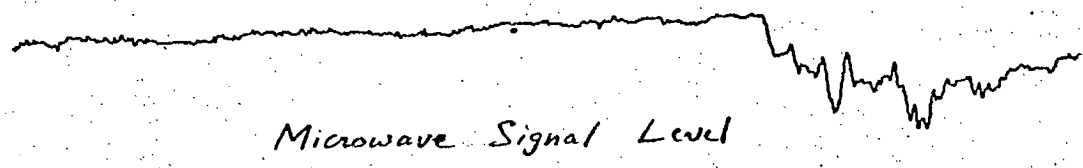
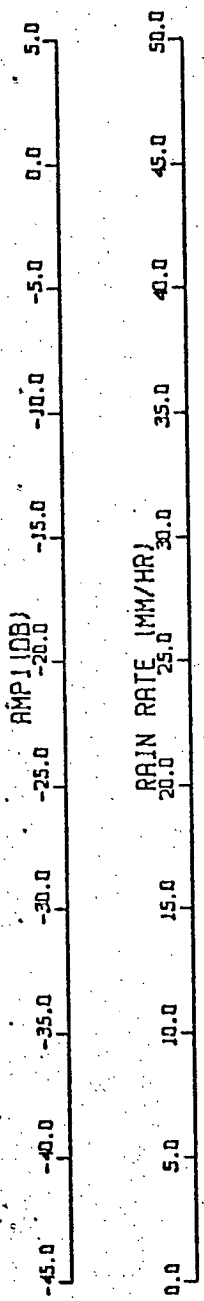
Although the two approaches have been followed, the work at present is concentrated on constructing an electrostatic device, similar to that described by Lammers\*. At this time, the instrument does not function properly and efforts are being made to improve the instrument and its associated amplifier to increase the sensitivity to a usable level.

Acknowledgement:

The valuable assistance of Mr. J.B. Peters during the course of the work and in the preparation of this report is gratefully acknowledged.

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\* Lammers U.H.W., "Electrostatic Analysis of Raindrop Distributions", J. Appl. Meteor., 8, pp.330-334, 1969.



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Fig. 1 (a)

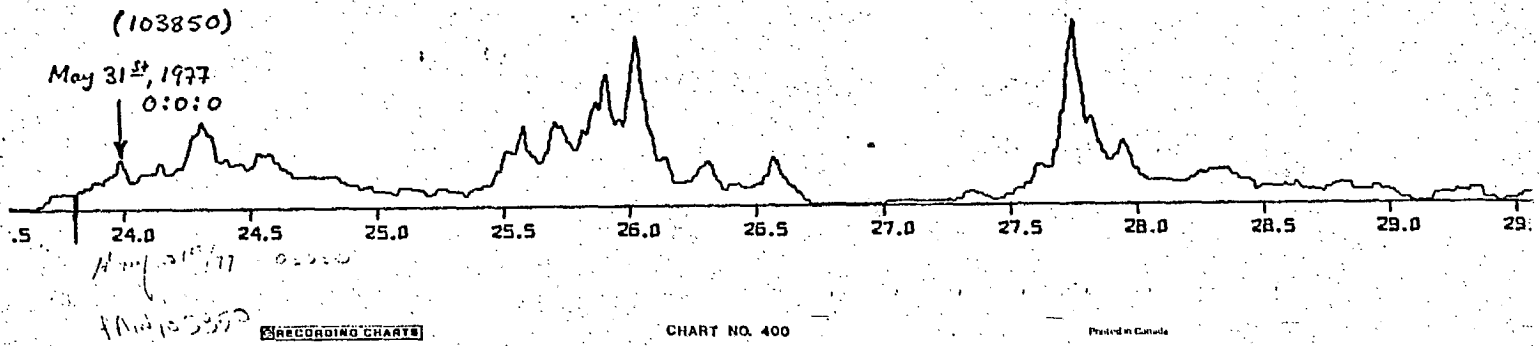
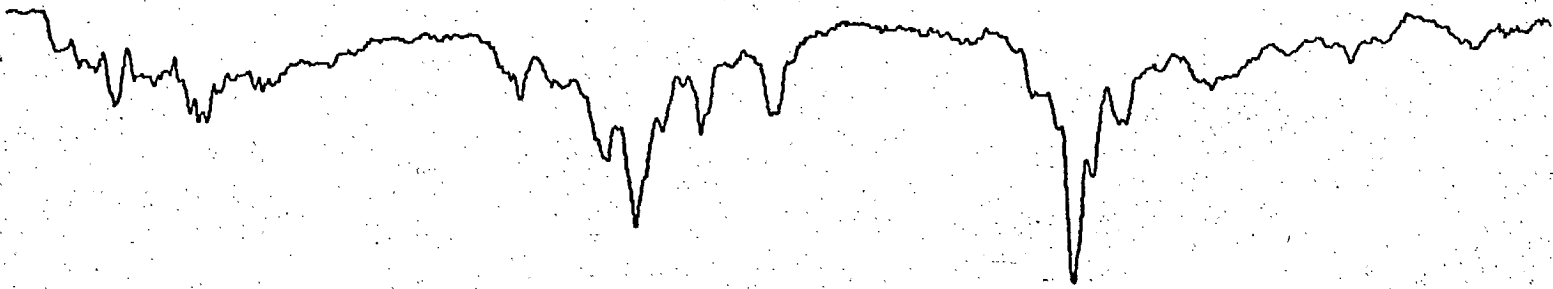
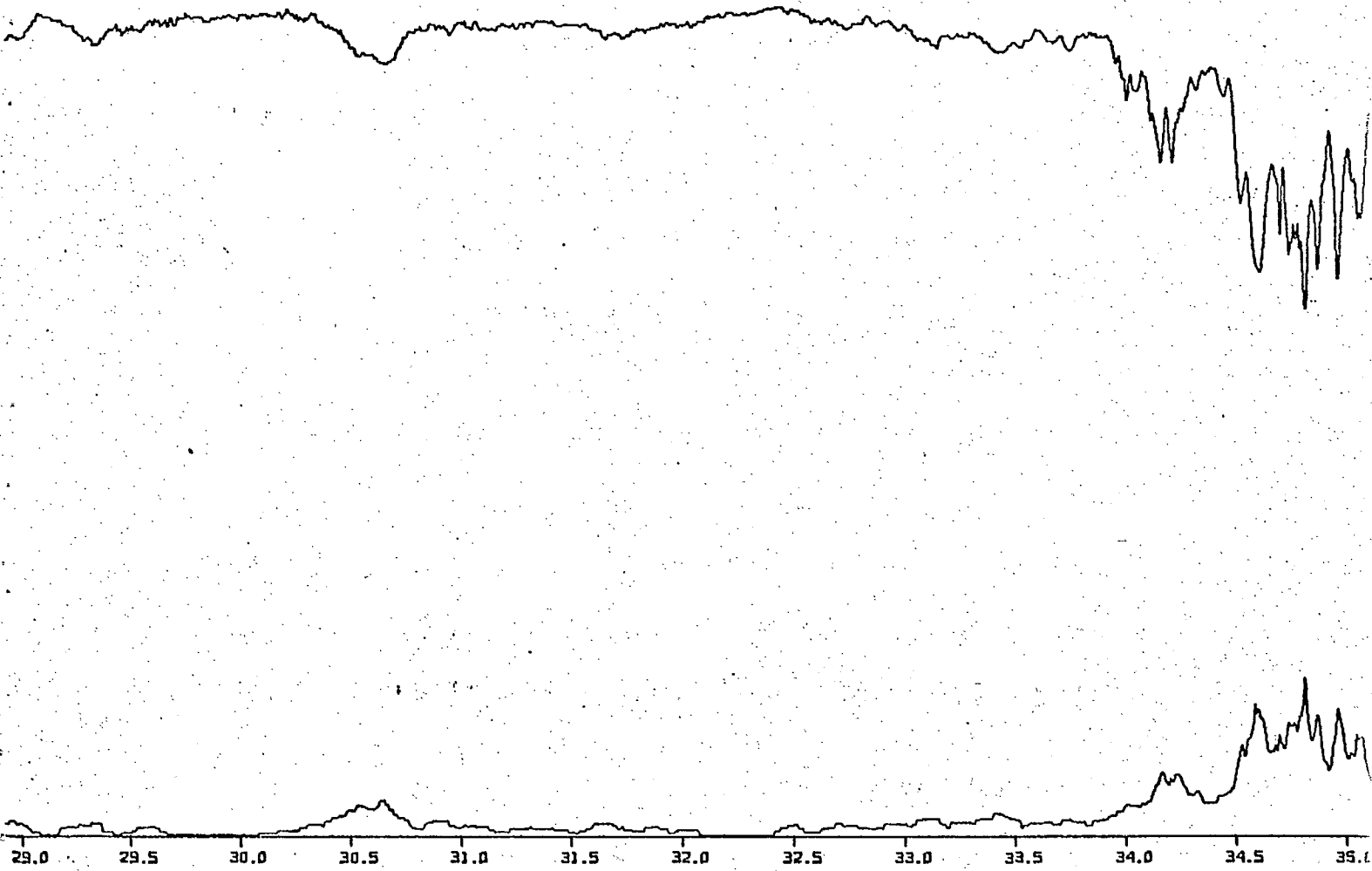


Fig. 1 (a) continued



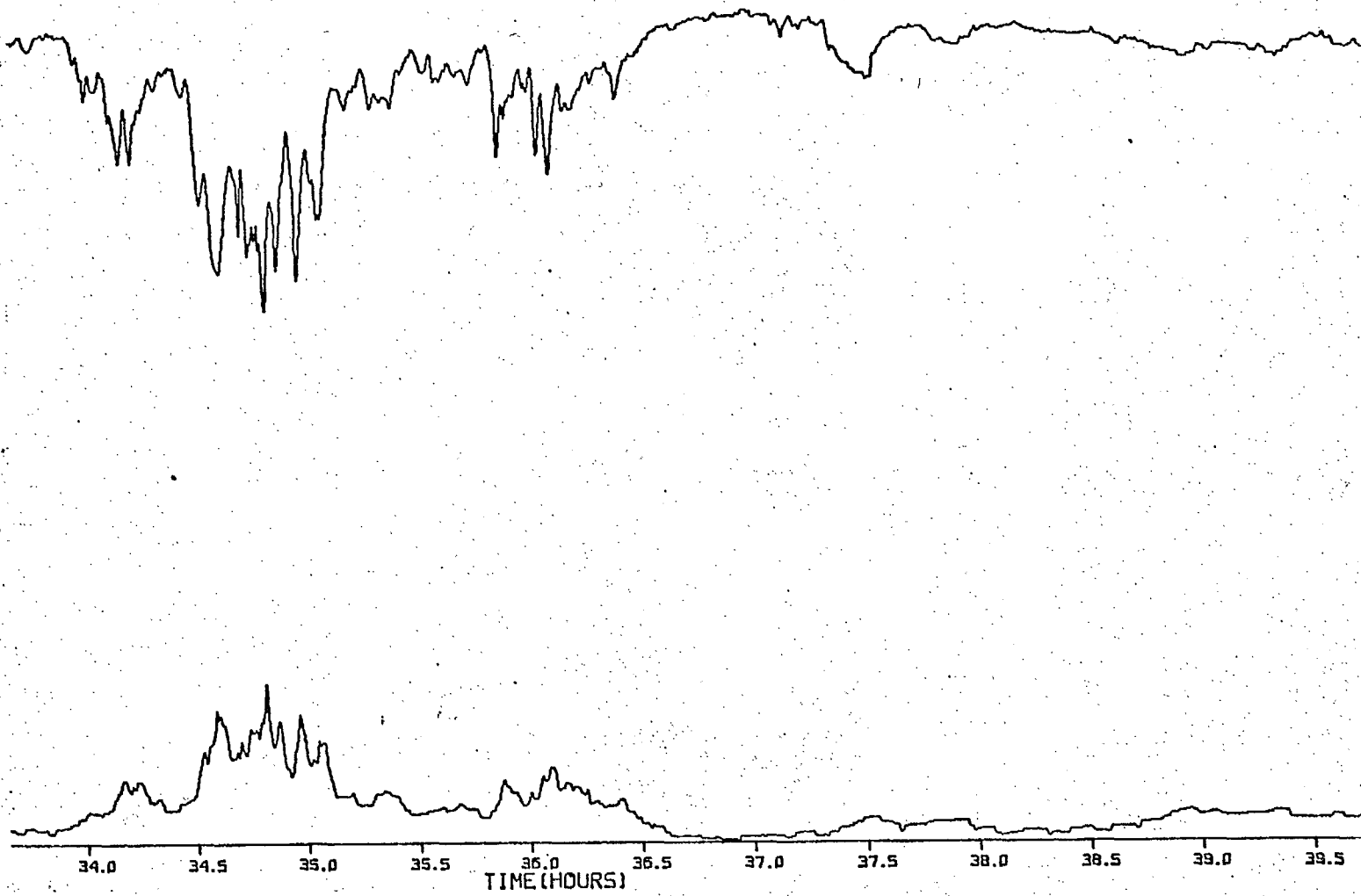


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Fig 1(a) Continued

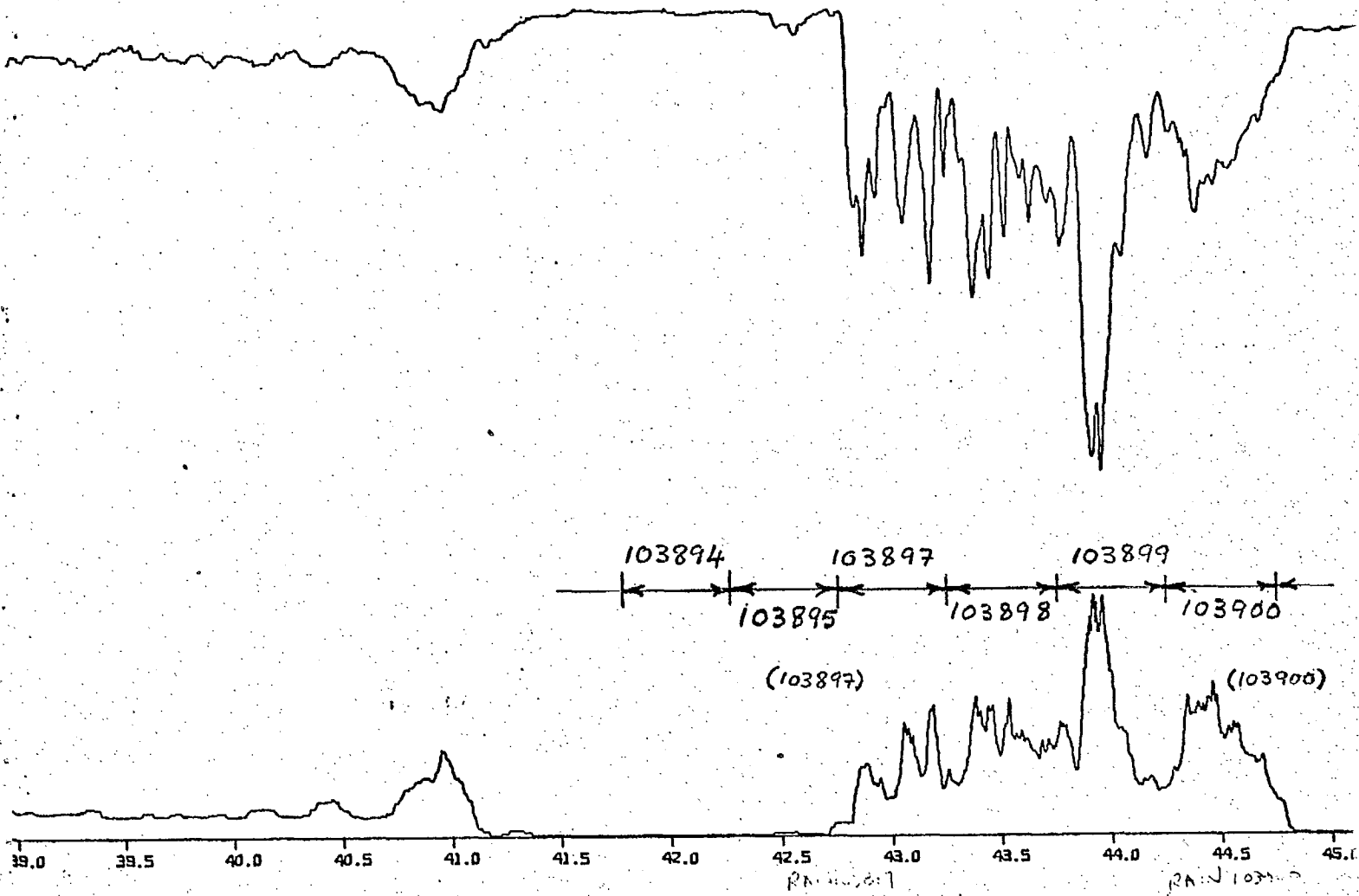


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Fig 1 (a) Continued

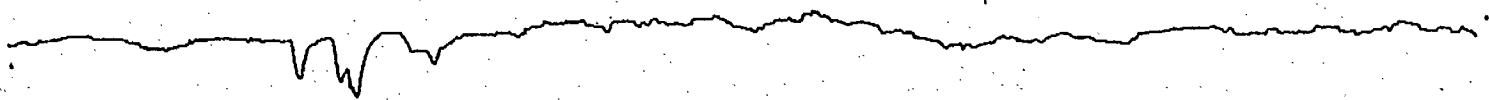


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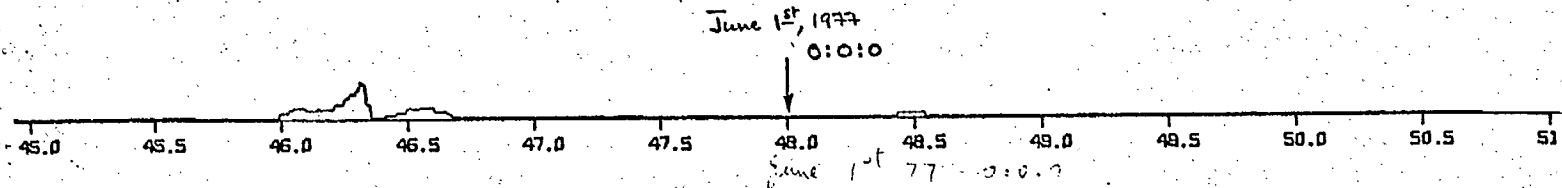
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Fig 1 (a) Continued



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Fig 1(a) continued

- 1 - JOSS ET AL. THUNDERSTORM DISTRIBUTION
  - 2 - LAWS AND PARSONS DISTRIBUTION
  - 3 - JOSS ET AL. WIDESPREAD DISTRIBUTION
  - 4 - MARSHALL-PALMER DISTRIBUTION
  - 5 - JOSS ET AL. DRIZZLE DISTRIBUTION
- ALL THE ABOVE AT F= 74.0 GHZ. T= 20 DEGREES C. M= (3.698,-2.181)

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See Fig 1(a), p. 10

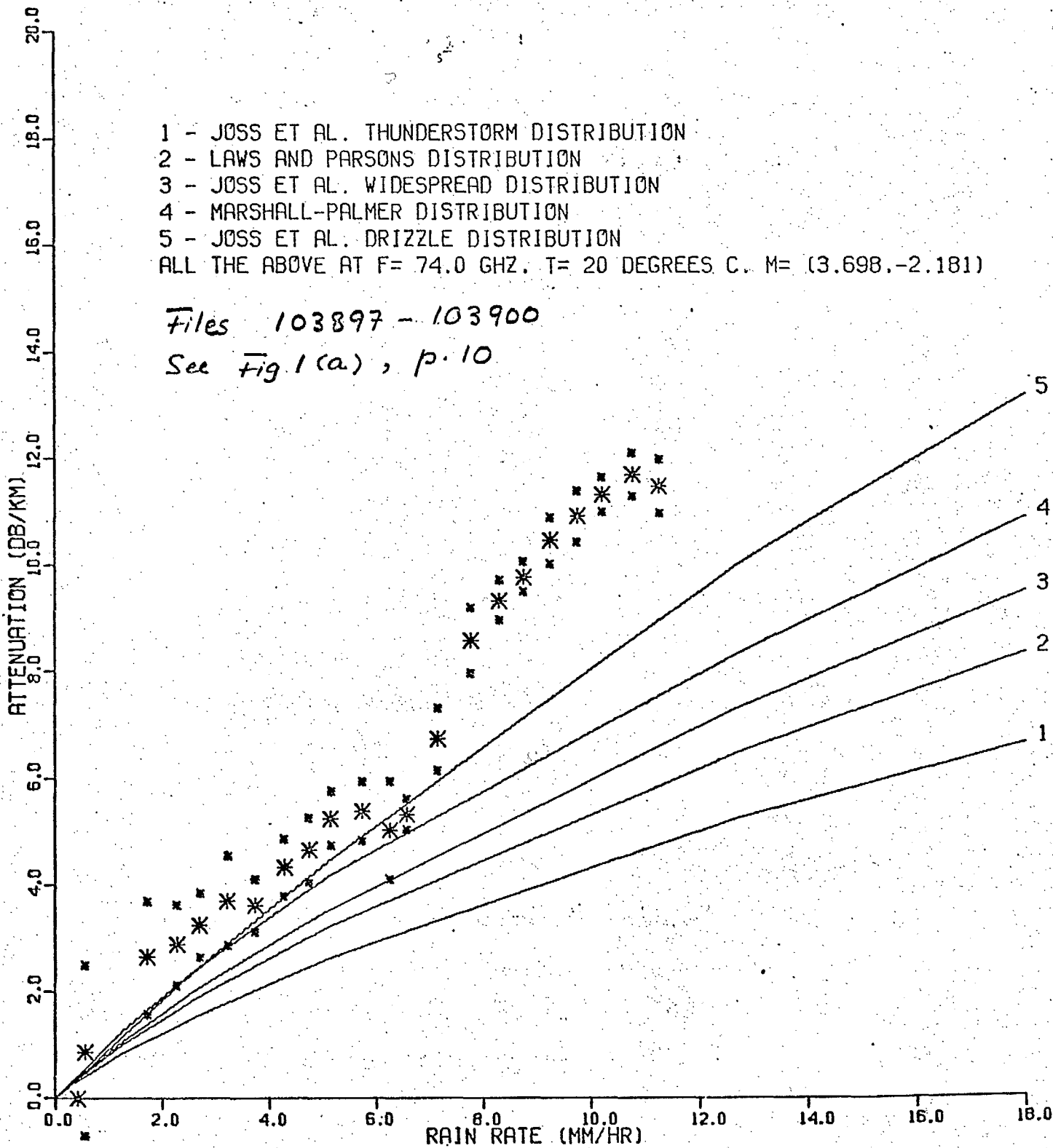


Fig 1 (b)

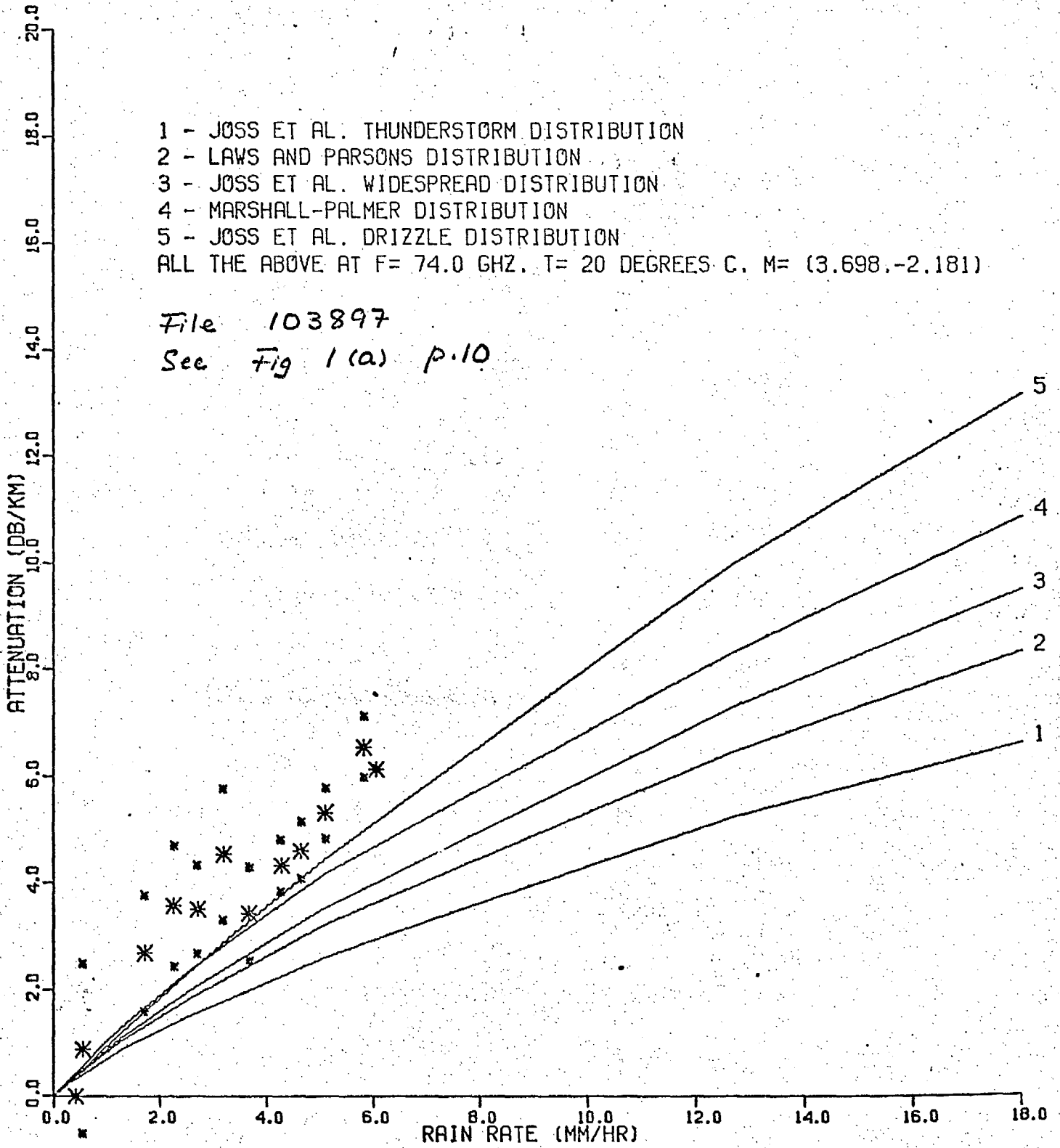


Fig 1 (c)

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  - 4 - MARSHALL-PALMER DISTRIBUTION
  - 5 - JOSS ET AL. DRIZZLE DISTRIBUTION
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See Fig 1(a) p. 10

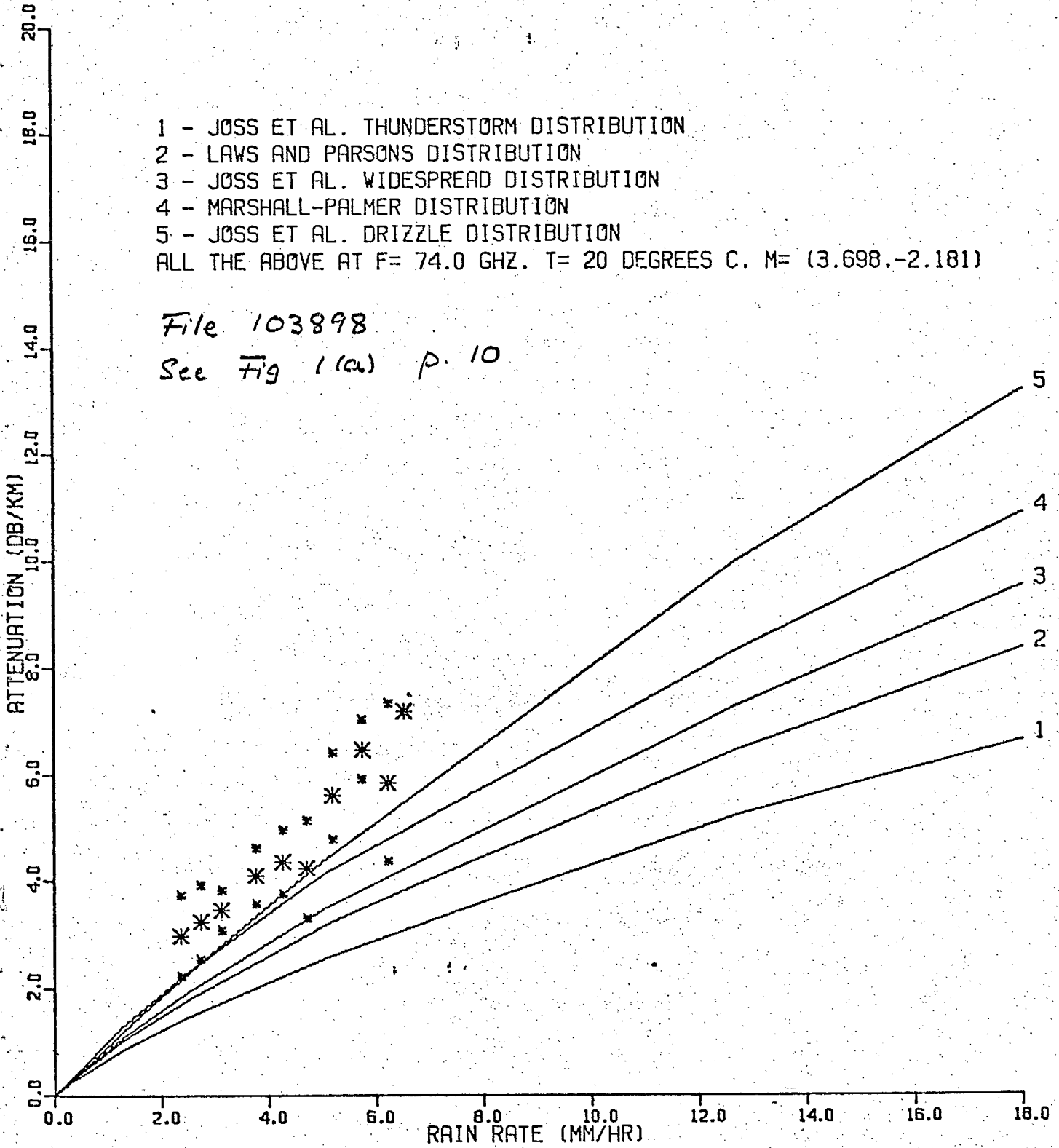
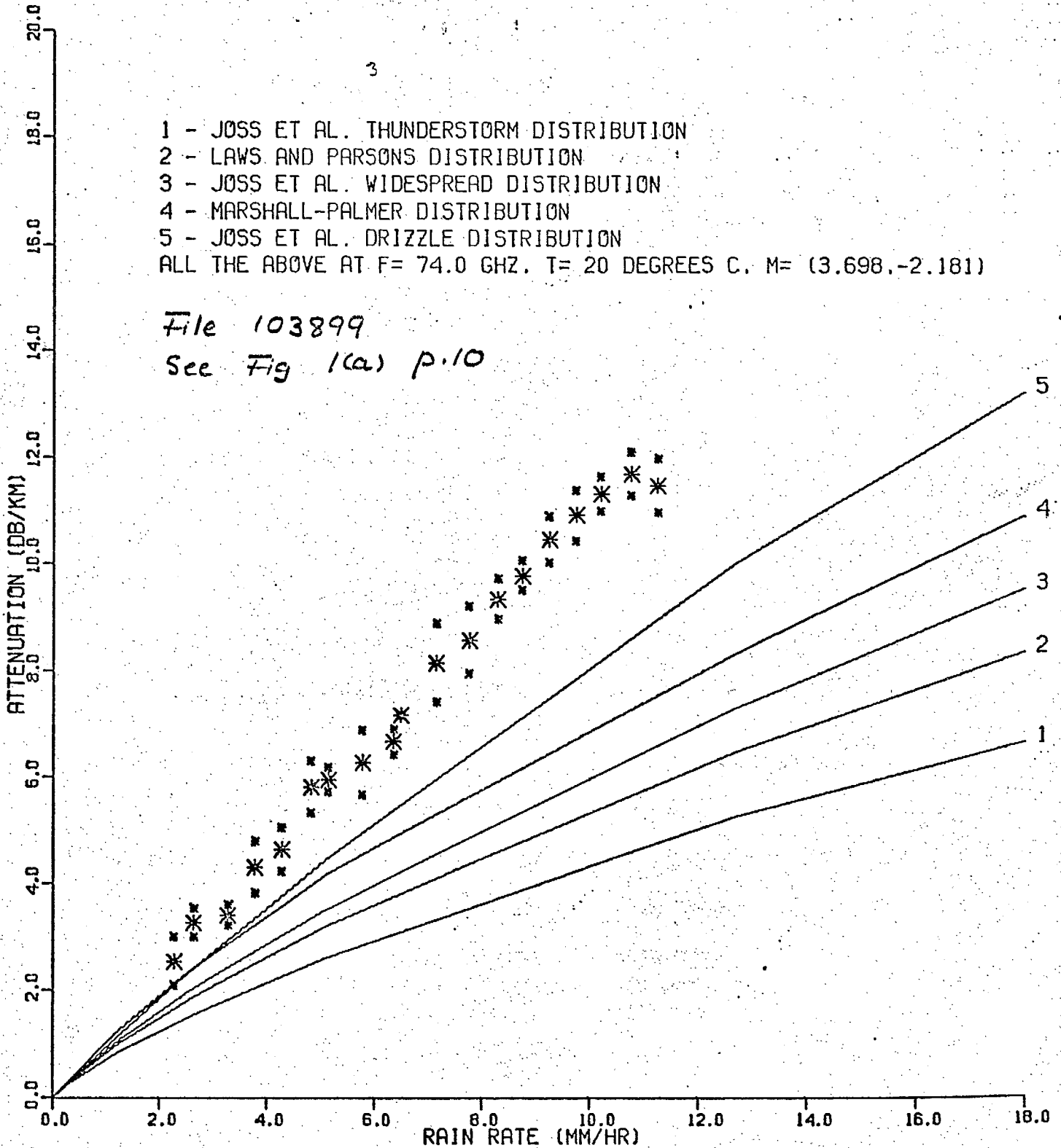


Fig 1 (d)

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1 - JOSS ET AL. THUNDERSTORM DISTRIBUTION  
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 3 - JOSS ET AL. WIDESPREAD DISTRIBUTION  
 4 - MARSHALL-PALMER DISTRIBUTION  
 5 - JOSS ET AL. DRIZZLE DISTRIBUTION  
 ALL THE ABOVE AT F = 74.0 GHZ, T = 20 DEGREES C, M = (3.698, -2.181)

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 See Fig 1(a) p.10



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Fig 1(c)



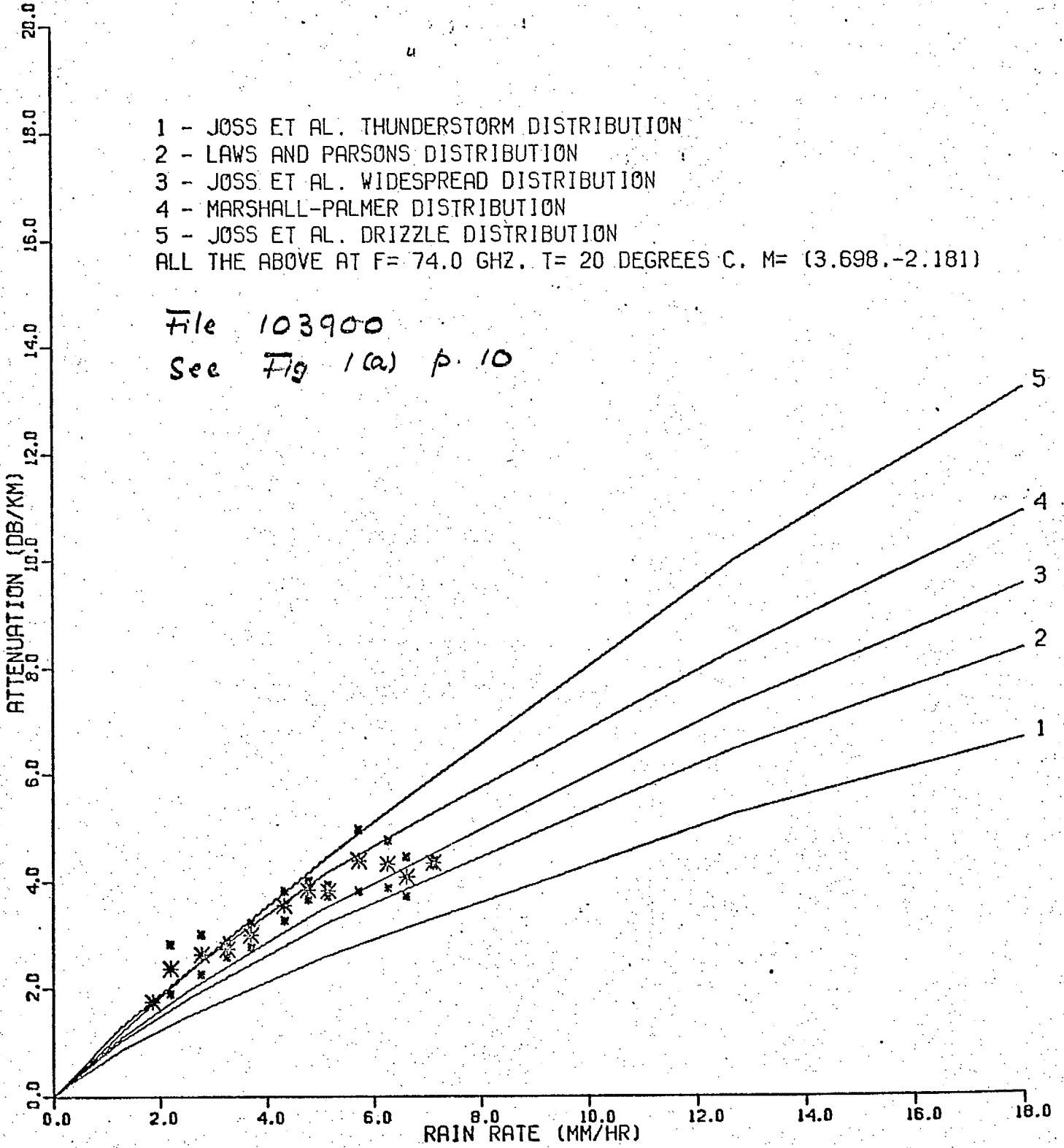


Fig 1 (f)

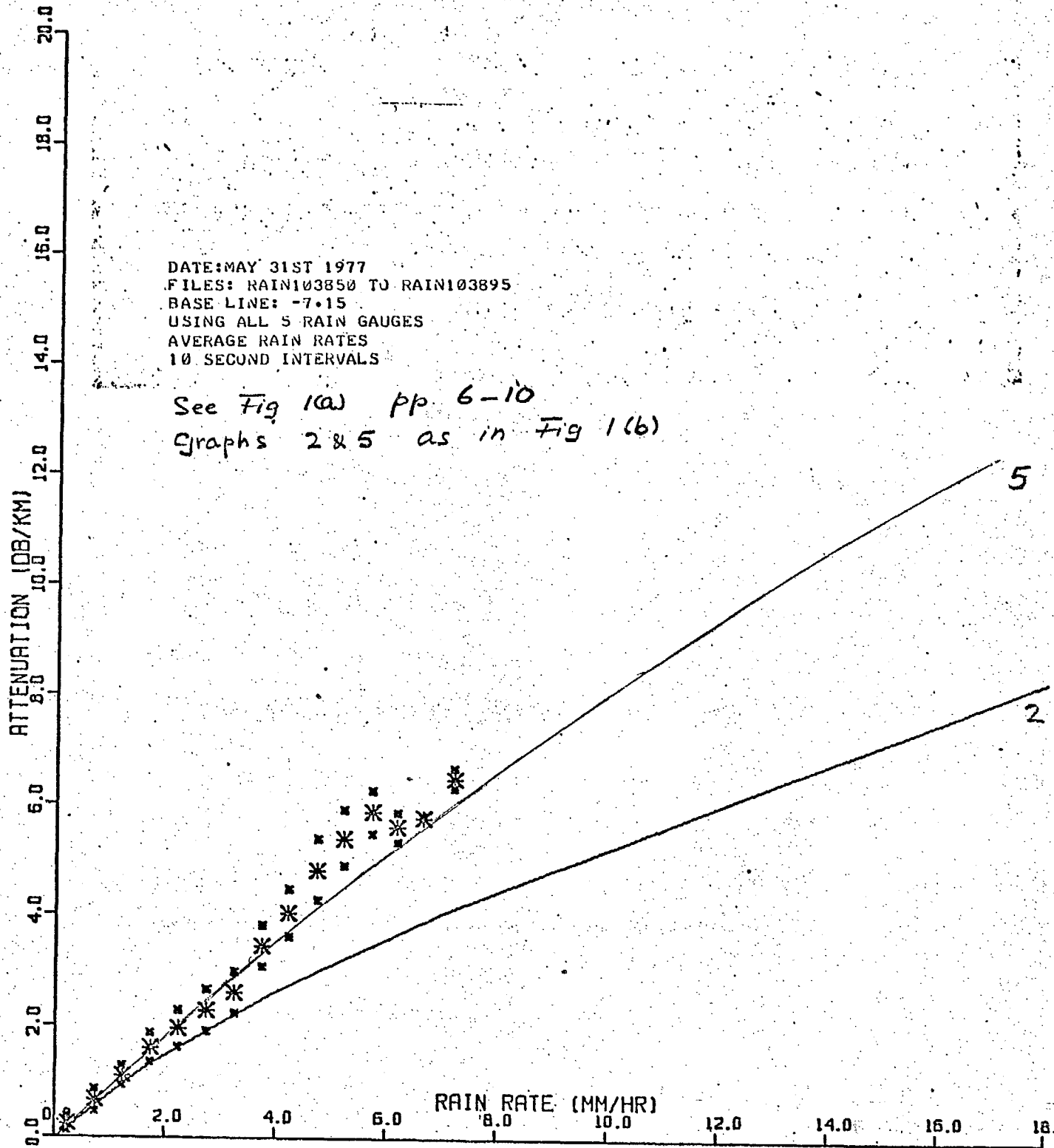


Fig 1 (g)

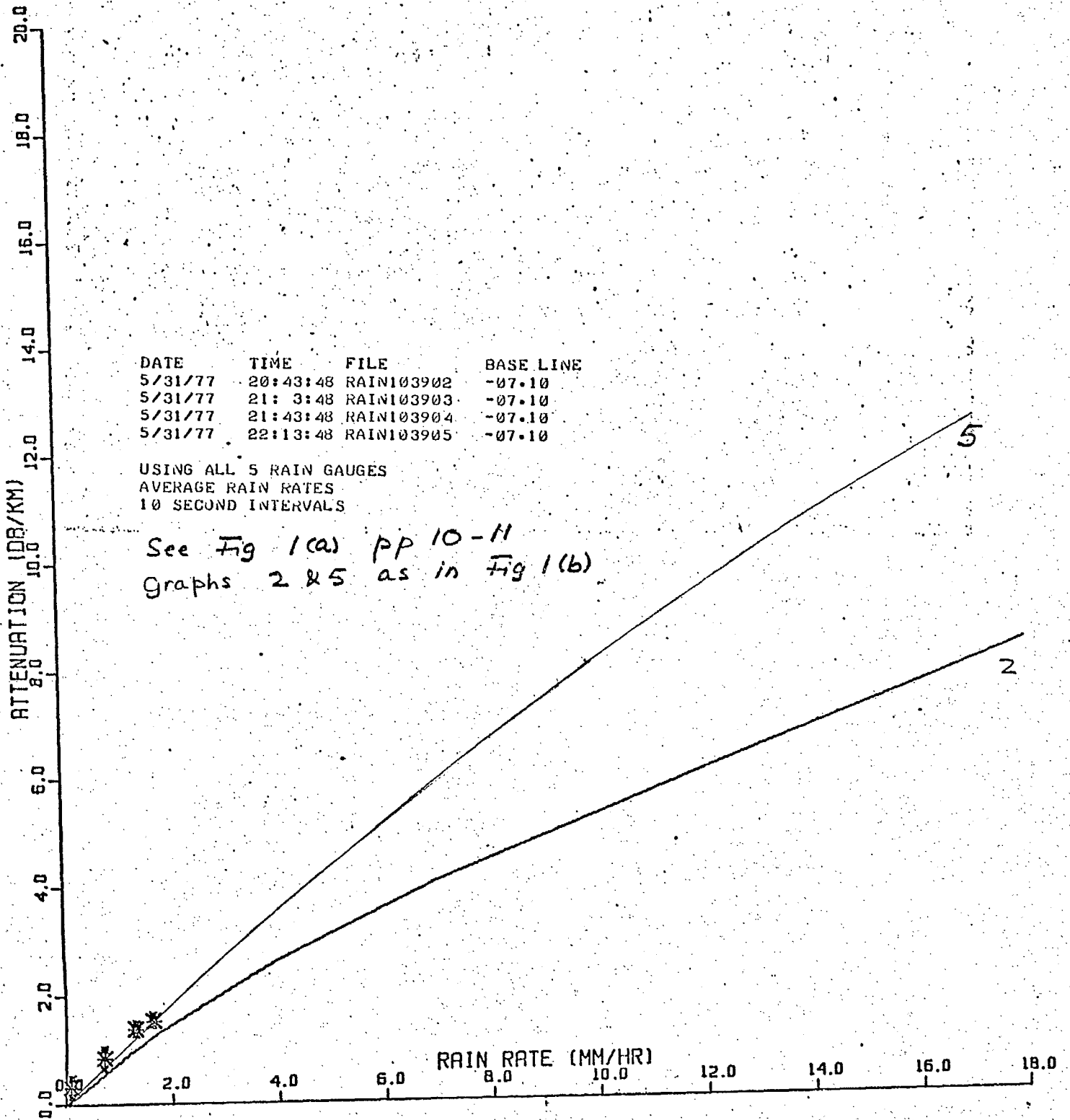


Fig 1 (h)

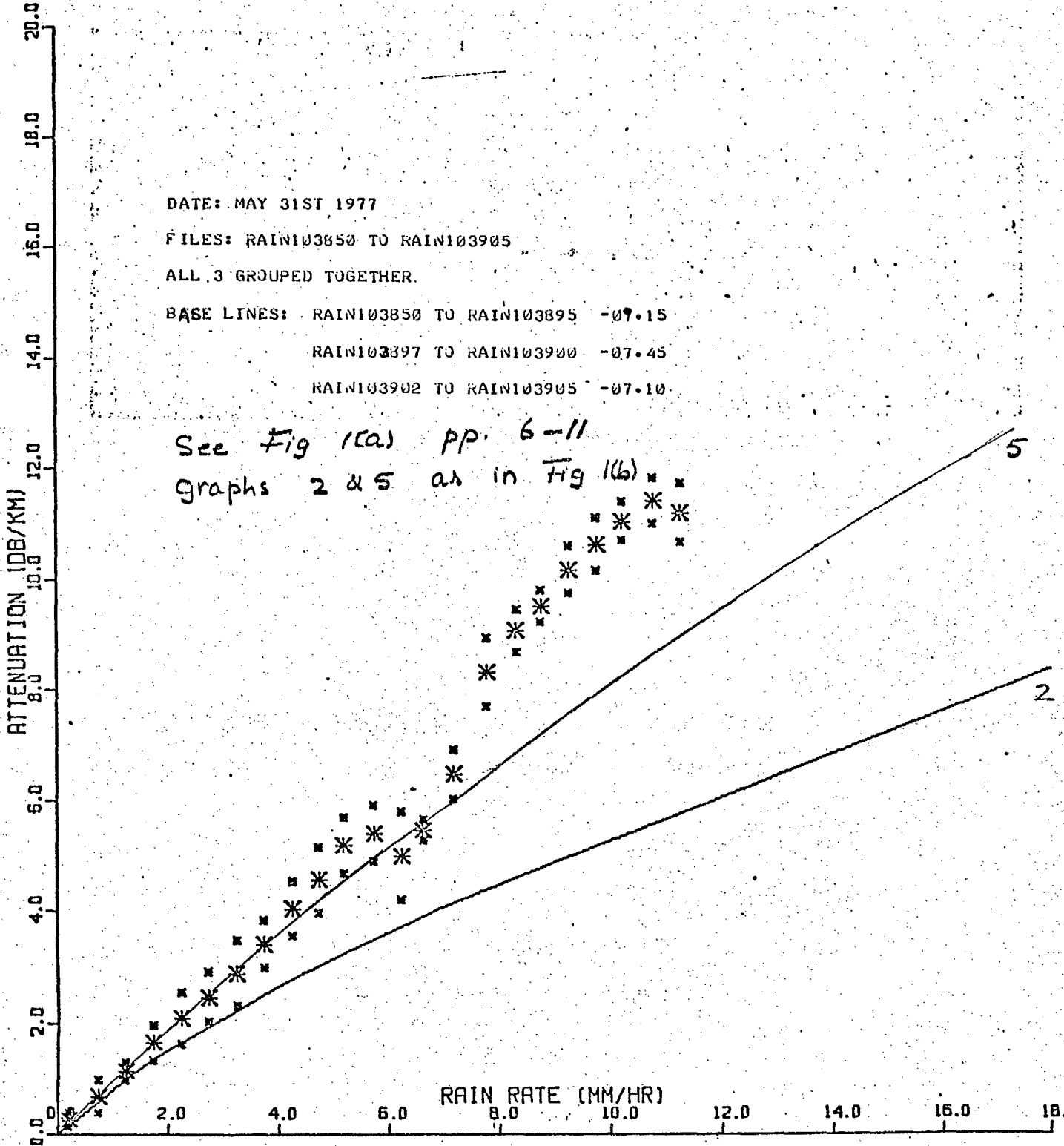


Fig. 1 (i)

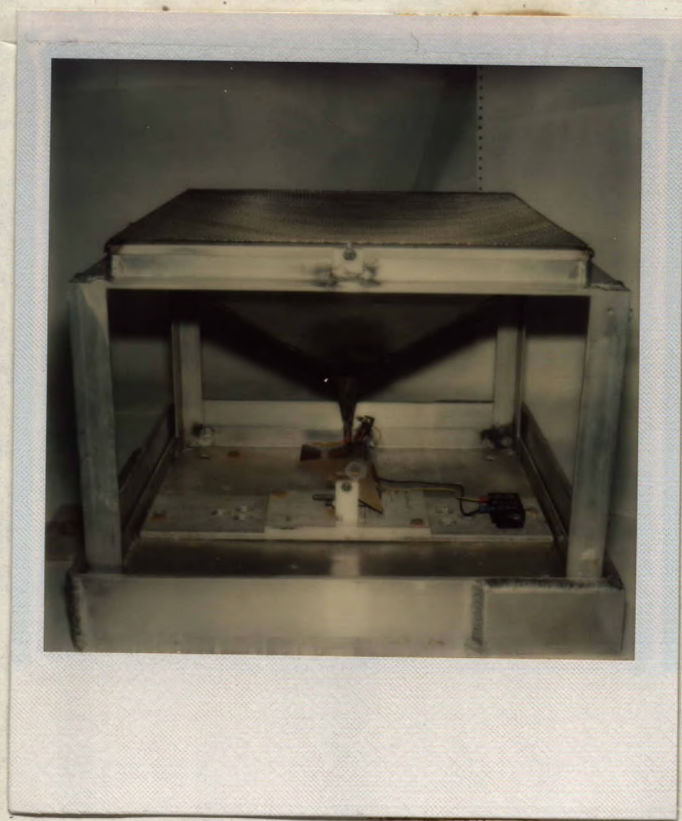


Fig. 2

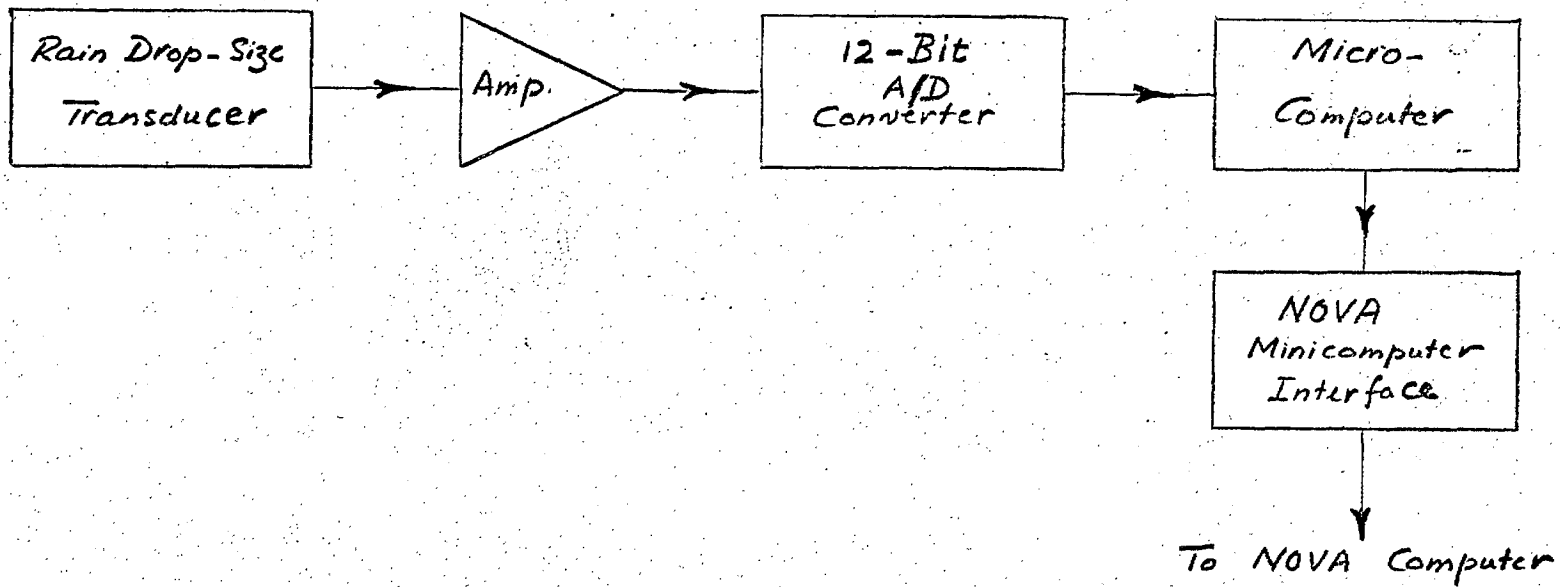


Fig. 3



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