USAFETAC/PR--93/004

"CLOUDIEST YEAR" STUDY

An Analysis of the 3DNEPH AND RTNEPH Databases

by

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APRIL 1993

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13. Abstract: Describes techniques used to analyze total cloud cover values from the USAF Environmental Technical Applications Center's nephanalysis databases: 3DNEPH and RTNEPH. Object of the study was to determine if total global cloud cover differed significantly on a year-to-year basis. Contoured global maps in an appendix show the results.

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PREFACE

This report describes the results of a study undertaken in support of USAFETAC Project 910821, "Cloudiest Year Study." The analyst was Mr Billy D. Bainter, USAFETAC/DOS.

The study was the result of a request from an AF Precedence 1-1 customer who asked for an analysis of USAFETAC's two nephanalysis databases, 3DNEPH and RTNEPH. The customer was concerned that some individual years of cloud data might be unrepresentatively cloudy, perhaps caused by errors in one or both of the nephanalysis models. The specific purpose of the analysis, therefore, was to determine if total global cloud cover differed significantly on a year-to-year basis over a given period of record.

To perform such a study, it was first necessary to reduce the number of eighth-mesh grid points (there were 391,819 of them "on-globe") to a number that would allow cost-effective computation and comparison for the entire 1977-1991 period of record used. "Whole-mesh" grid spacing was used after testing alternatives, such as quarter- and half-mesh.

The study showed that there is no single month in any year that can be said to be the "cloudiest month" worldwide, and that maximum cloud cover varies by year and month according to geographical area. If the customer's concerns were valid, large portions of the globe (if not all of it) would have been identified as having the same "cloudiest year." Instead, the graphics products produced during the study show complex patterns of many different "cloudiest years" over different parts of the world. This conclusion, the result of normal year-to-year and area-to-area climatic variations, was expected.

CONTENTS

1. BACKGROUND. Nephanalysis data from the Air Force Global Weather Central's (AFGWC's) two nephanalysis models (3-Dimensional Nephanalysis, or 3DNEPH, and Real-Time Nephanalysis, or RTNEPH) has been archived by USAFETAC's Operating Location A at Asheville, NC, since 1973. It has been used and applied by USAFETAC analysts since the data became part of the Air Weather Service's overall operational database.

USAFETAC is frequently asked how one year's nephanalysis data compares with another in terms of global cloudiness. Up to now, that question hasn't been answered because of the immensity of the 3DNEPH and RTNEPH databases. But by combining new technologies with a scheme to reduce data volume, USAFETAC/DOS was recently able to rank data by years and months to determine the existence or non-existence of so-called "cloudiest"' periods. The study, the results of which are documented here, used 3DNEPH and RTNEPH data from 1977 to 1991 to determine the years and months with maximum mean total cloudiness.

2. METHODOLOGY

2.1 Nephanalysis Data. The AFGWC automated cloud analysis model became operational in January 1970. First known as "3DNEPH" (3-dimensional nephanalysis), this computer model was developed to allow maximum use of increasing quantities of meteorological cloud information, especially satellite imagery, the heart of the system. The 3DNEPH analysis database is specified at a horizontal resolution of about 25 nautical miles.

The 3DNEPH *horizontal* grid, a subset of AFGWC'S basic horizontal 200-nm macroscale grid, is one-eighth of the 200-nm grid and therefore referred to as the "eighth-mesh" grid. It consists of a 512 by 512 array centered at the poles and oriented on 80 degrees west longitude. The grid is further subdivided into 64 equally sized areas called "3DNEPH boxes."

The 3DNEPH *vertical* grid consists of 15 layers of varying thickness from the surface to 55,000 feet. These 15 layers are divided into two subsets:

- Six terrain-following layers are specified according to local terrain height.
- The other nine layers are specified with respect to mean sea level.

In late 1983 the Real-Time Nephanalysis (RTNEPH)) model replaced 3DNEPH. The newer model uses the same horizontal grid spacing as the 3DNEPH model, but uses four floating layers in the vertical rather than the 15 fixed layers used in 3DNEPH. In addition, RTNEPH data contains source and diagnostic information that improves quality control.

2.2 Periods of Record. Analyses for eight times a day on each synoptic hour (00, 03, 06, 09, 12, 15, 18, and 21Z) are available from both the 3DNEPH and RTNEPH databases, except during the period January 1977 through July 1978 when only 03, 09, 15, and 21Z data is available for the Southern Hemisphere. The table on the next page shows the POR for each hemisphere and data type.

HEMISPHERE	TYPE	POR
North	3DNEPH	January 73 - December 83
South	3DNEPH	January 77 - December 83
North	RTNEPH	January 84 - Present
South	RTNEPH	January 84 - Present

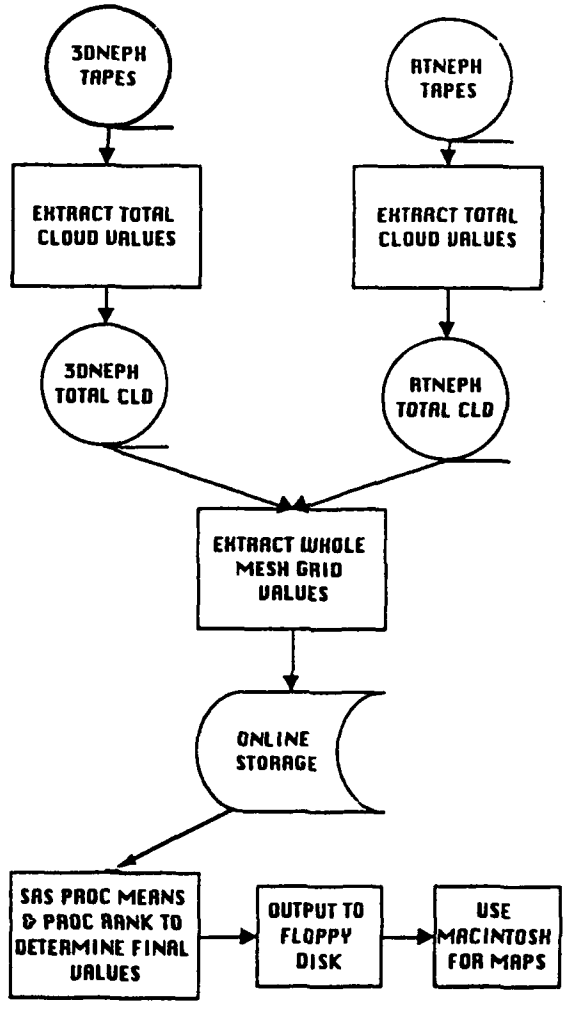
2.3 Data Type Comparisons. The 3DNEPH and RTNEPH models are similar, but the 3DNEPH model used 15 *fixed* layers in the atmosphere to record cloud data while the RTNEPH model uses four *floating* layers. Both models use the eighth-mesh polar-stereographic grid . Both provide data of the characteristics of the cloud cover for the grid point(s) in question, but only *total* cloud-cover value was used in this study.

- 3DNEPH data is archived by "NEPH BOX," with 6 months of data (January-June or July-December) on a 2,400-foot , 9-track tape.

- RTNEPH data is also archived by "NEPH BOX," but with 4 months of data (January-April, May-August, or Septem-ber- December) on a 2,400-foot, 9-track tape.

For the entire globe and period of record used in this study (1977-1991), there were 1,680 3DNEPH tapes and 5,760 RTNEPH tapes. Together, they represented about 5,000 megabytes of raw data.

2.4 Data Computations. The enormous volume of raw data in these two databases far exceeded the on-line storage capacity of USAFETAC's IBM 3090 mainframe computer. Since all the data was stored on tape, it would have taken about 31 continuous 24-hour days just to *read in* all the data, even if the mainframe were capable of holding it. Therefore, USAFETAC was forced to look for a simpler way to process the data. The simplified method chosen is shown by the diagram below.



Even after simplification, many months were required to process and display the data. SAS software was used, primarily PROC MEANS for determining the mean monthly total cloud cover for each grid point and PROC RANK for ranking the year-months.

The processed data was downloaded from the mainframe to 3.5-inch diskettes, which were then read into an Apple Macintosh IIci computer and SPYGLASS TRANSFORM software for contouring and mapping. The final results are displayed in the appendix as familiar global Mercator projections for easy visual analysis. Although the maps in the appendix are black and white, color versions are available for special applications by calling USAFETAC/DOS, DSN 576-3543.

2.5 Data Analysis. Analysis of the monthly charts, as shown in the table below, showed no apparent trends. This was not a surprise, since cloudiness is expected to vary by year and month from one geographic location or climatic regime to another. In other words, there is no one single worldwide "cloudiest year" or "cloudiest month." It should be possible to compare these maps with years and months of known weather phenomena (e.g., ENSO or other climatic extremes), but such a comparison was not attempted during this study. Note that 1984 and 1985 show low cloudiness percentages for all months, but USAFETAC does not believe that these low percentages are due to the models; the changes are not that great and the overall trend toward the lower percentages began before the RTNEPH model became operational.

PERCENTAGE OF GRID POINTS WITH THE SAME YEAR AND MONTH OF MAXIMUM TOTAL CLOUD COVER. Asterisks (*) indicate less than 5%.

	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Jan	*	9	6	*	10	8	11	*	*	5	18	5	7	6	*
Feb	7	11	1	*	10	8	11	*	*	13	8	*	7	6	*
Mar	*	10	4	10	12	11	13	*	*	15	*	*	*	*	
Apr	*	15	*	9	11	6	14	*	*	6	9	*	*	5	*
May	5	11	*	6	6	15	14	*	*	*	6	6	*	6	9
Jun	7	6	15	*	8	7	12	*	*	6	8	5	*	6	12
Jul	16	8	12	*	5	7	8	*	*	6	8	6	*	6	11
Aug	11	8	9	5	6	10	7	*	*	*	9	10	*	6	12
Sep	10	6	10	7	6	11	8	*	*	12	*	*	6	12	
Oct	8	5	7	12	5	19	*	8	7	*	8	*	*	5	7
Nov	6	5	8	14	8	15	*	5	6	*	5	*	6	5	8
Dec	7	5	7	15	8	12	*	*	11	6	6	*	6	5	*

3. SUMMARY. Using the methods outlined in this report, it was possible to process and analyze the 3DNEPH and RTNEPH databases for the entire period of record. This study only determined a *general* comparison of the two databases; we did not, for example, determine a year and month with the highest mean total cloud cover that covered the largest geographical area. Using similar methods, however, it should be possible to do an in-depth statistical study for limited geographical areas and the entire period of record. It should also be possible to use the data from this study to determine if and how a particular climatic event such as an ENSO or volcanic eruption might have affected a specific area or the entire planet. Further study and advanced statistical assessment is required, however, to answer specific questions relating to the models and cloud cover.

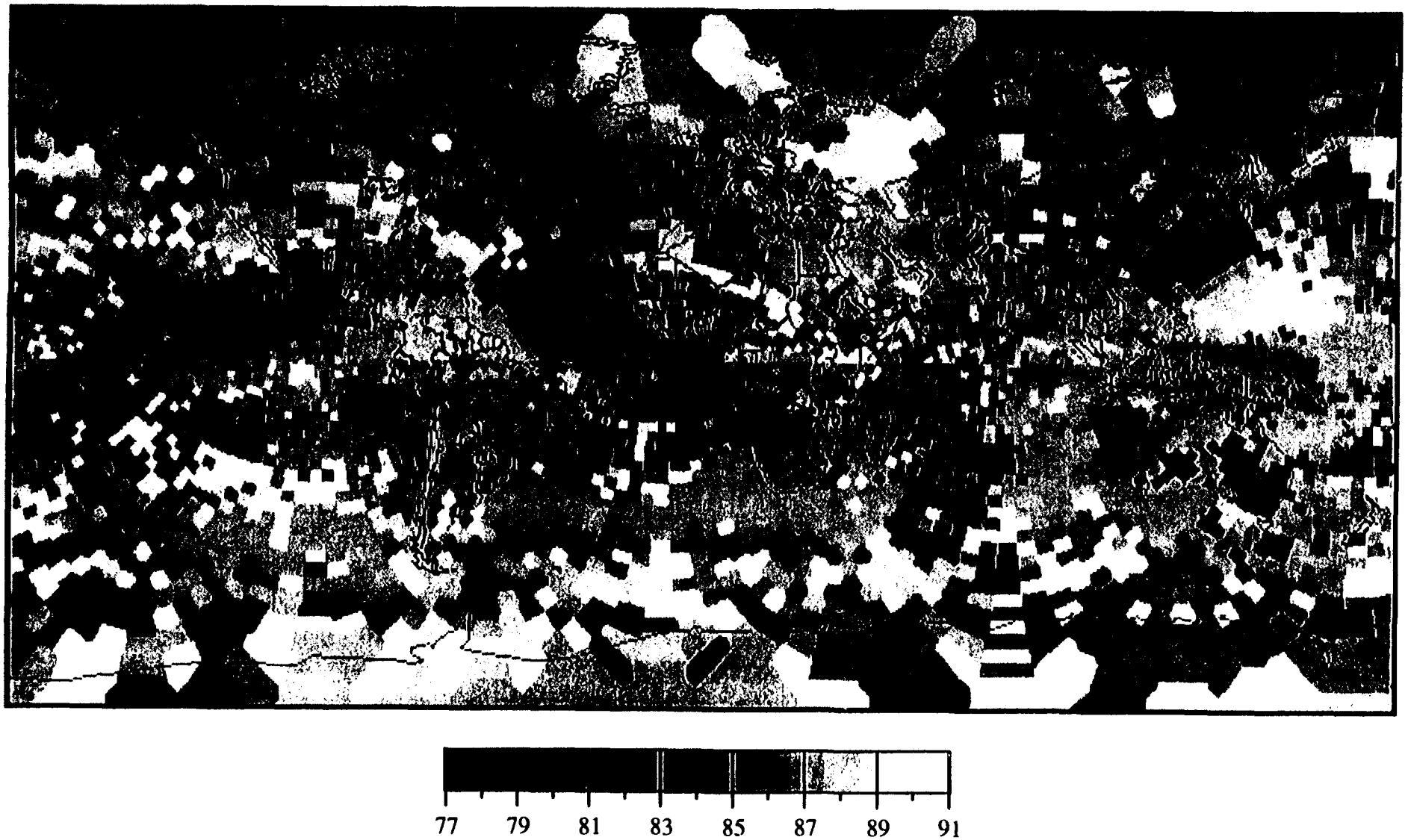
APPENDIX

MONTHLY YEAR OF MAX MEAN TOTAL CLOUD COVER

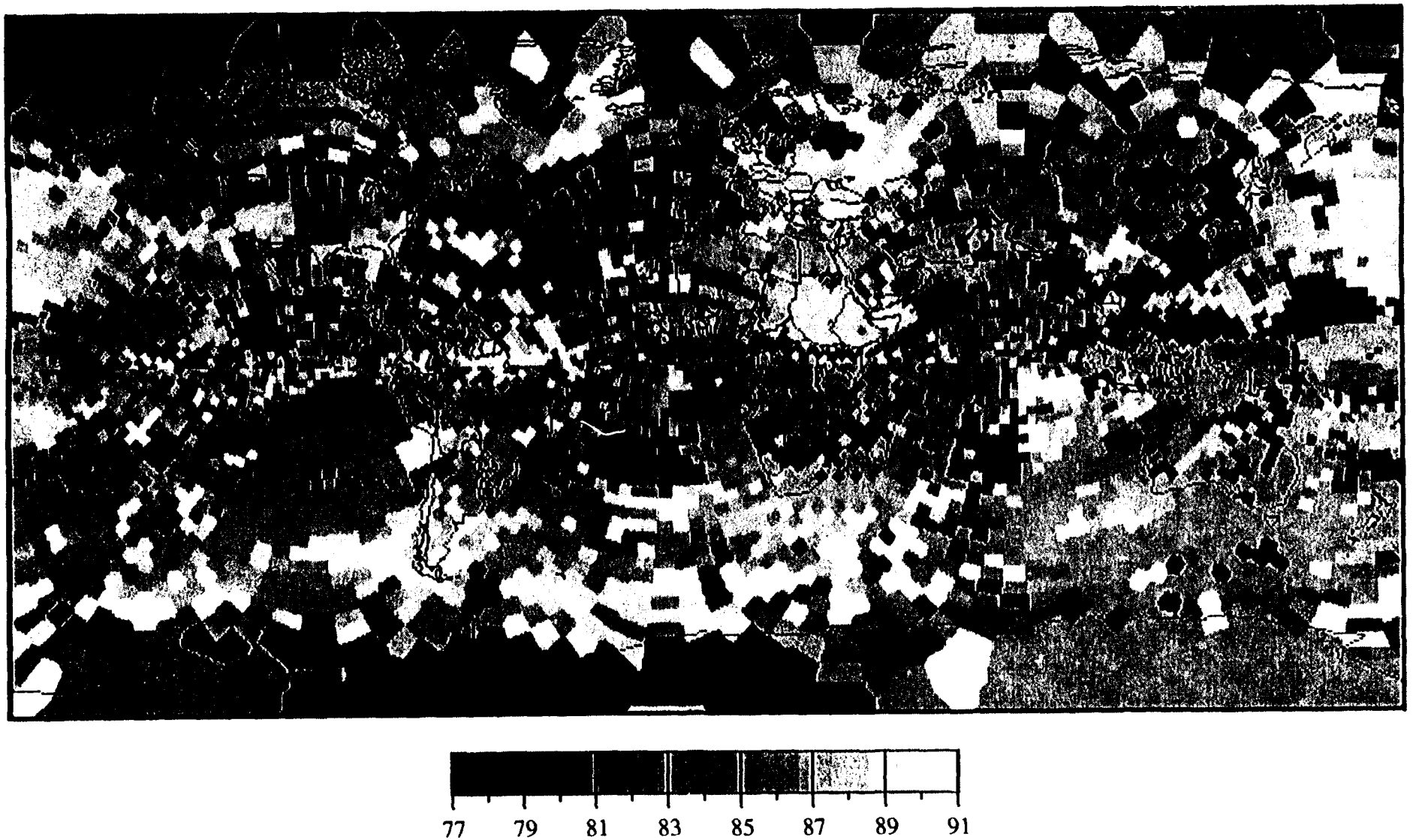
FROM 3DNEPH AND RTNEPH DATABASES

Study results month-by-month) are displayed in the appendix as familiar global Mercator projections for easy visual analysis. Although the maps are black and white, color versions are available for special applications by calling USAFETAC/ DOS, DSN 576-3543.

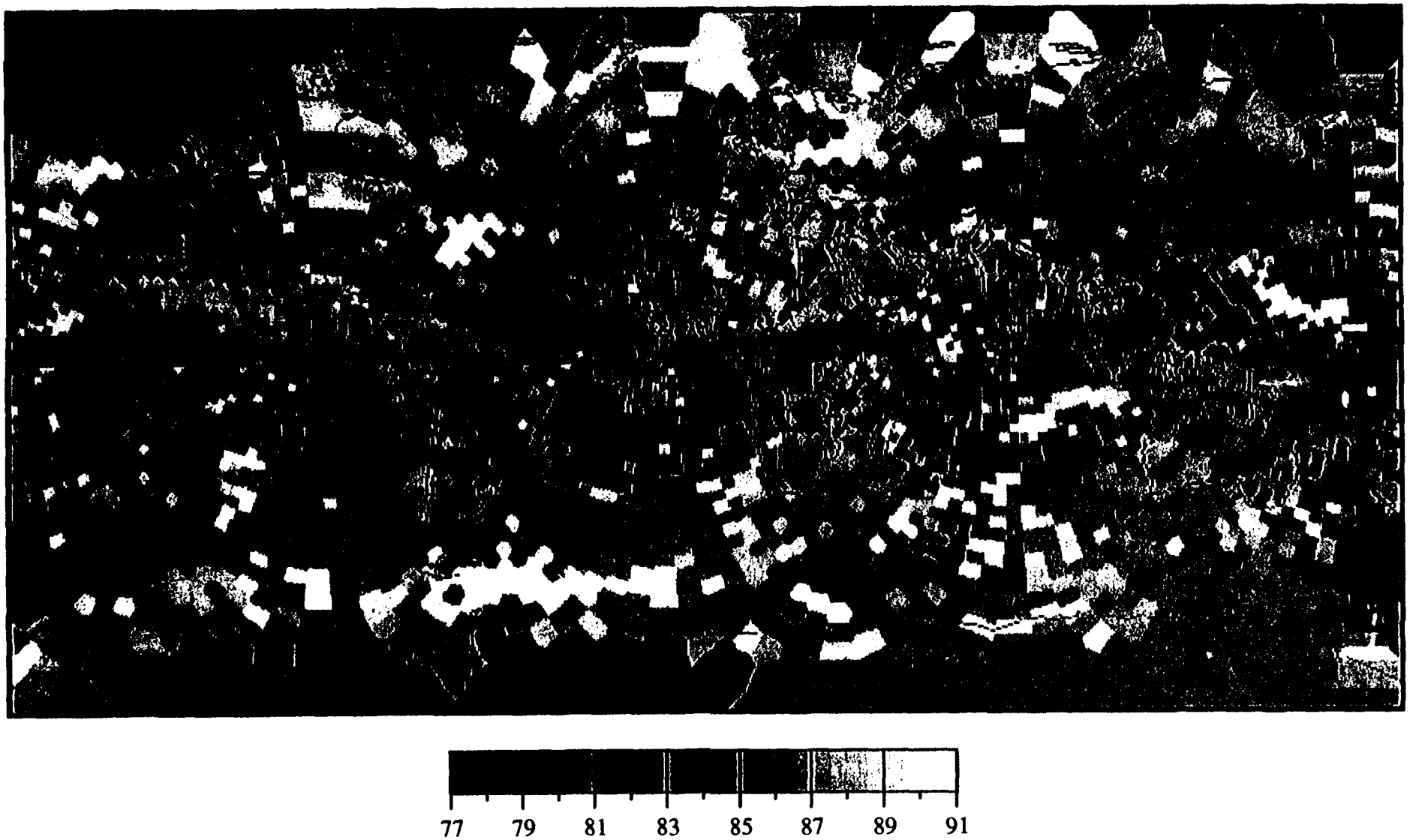
JANUARY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



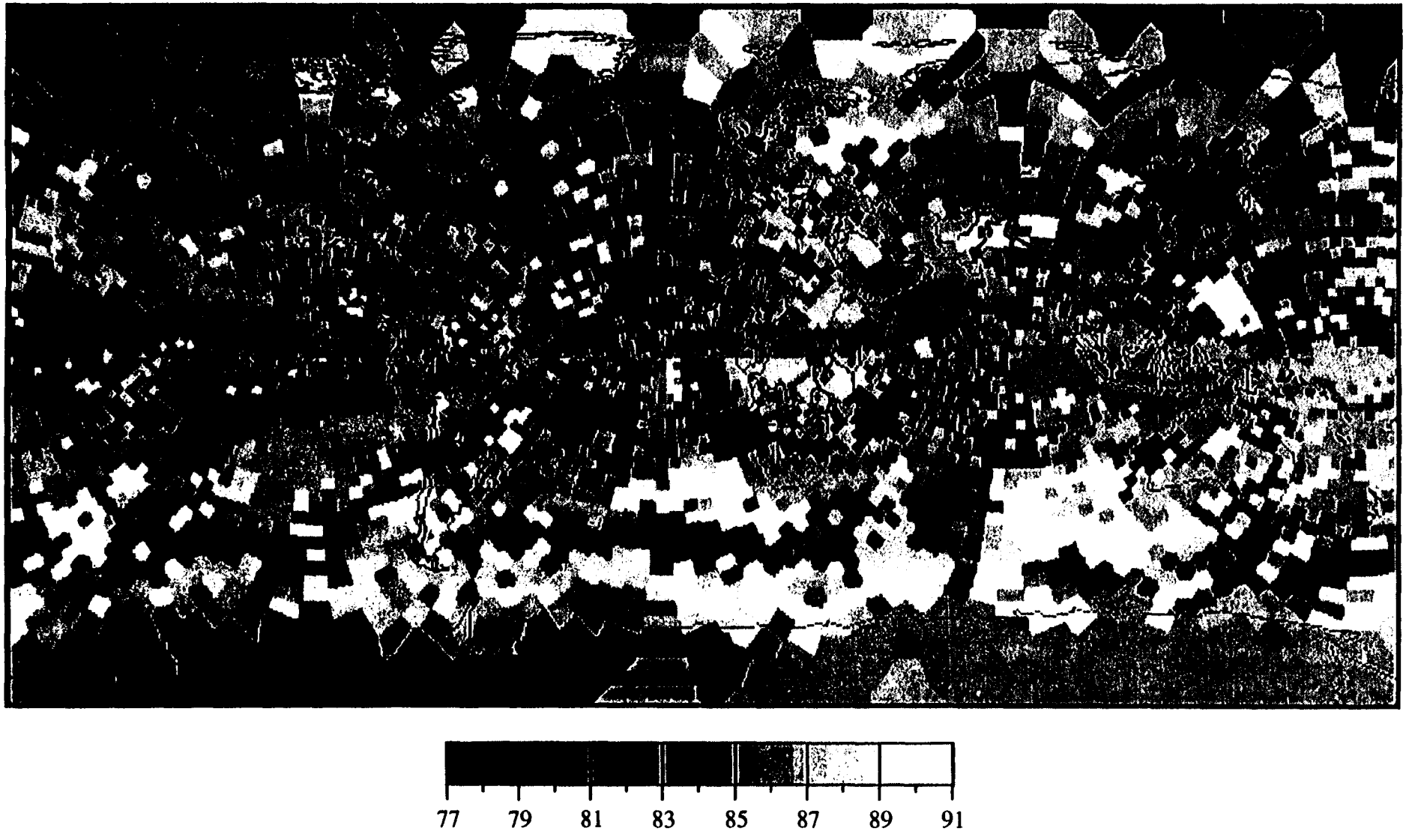
FEBRUARY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



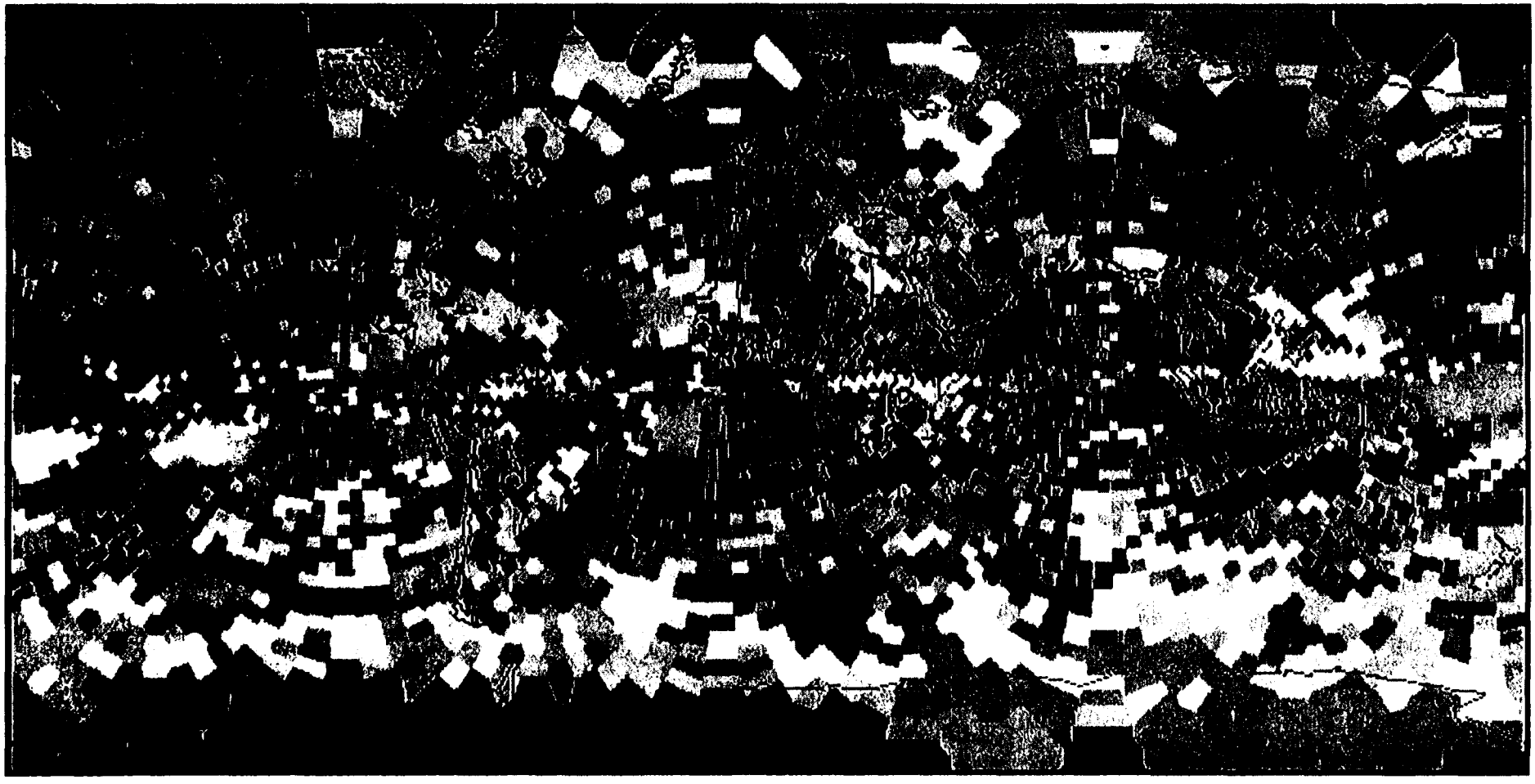
MARCH
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



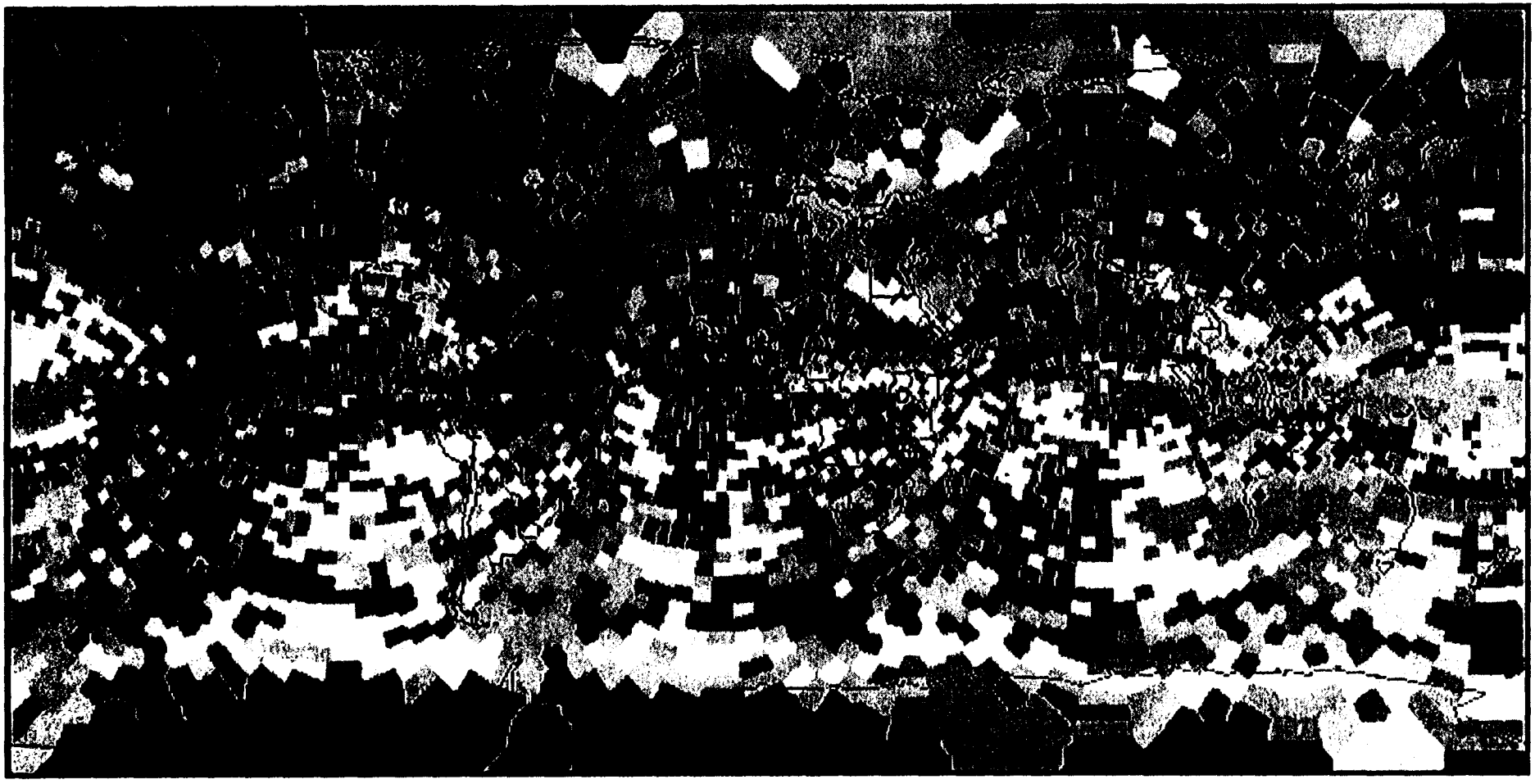
APRIL
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



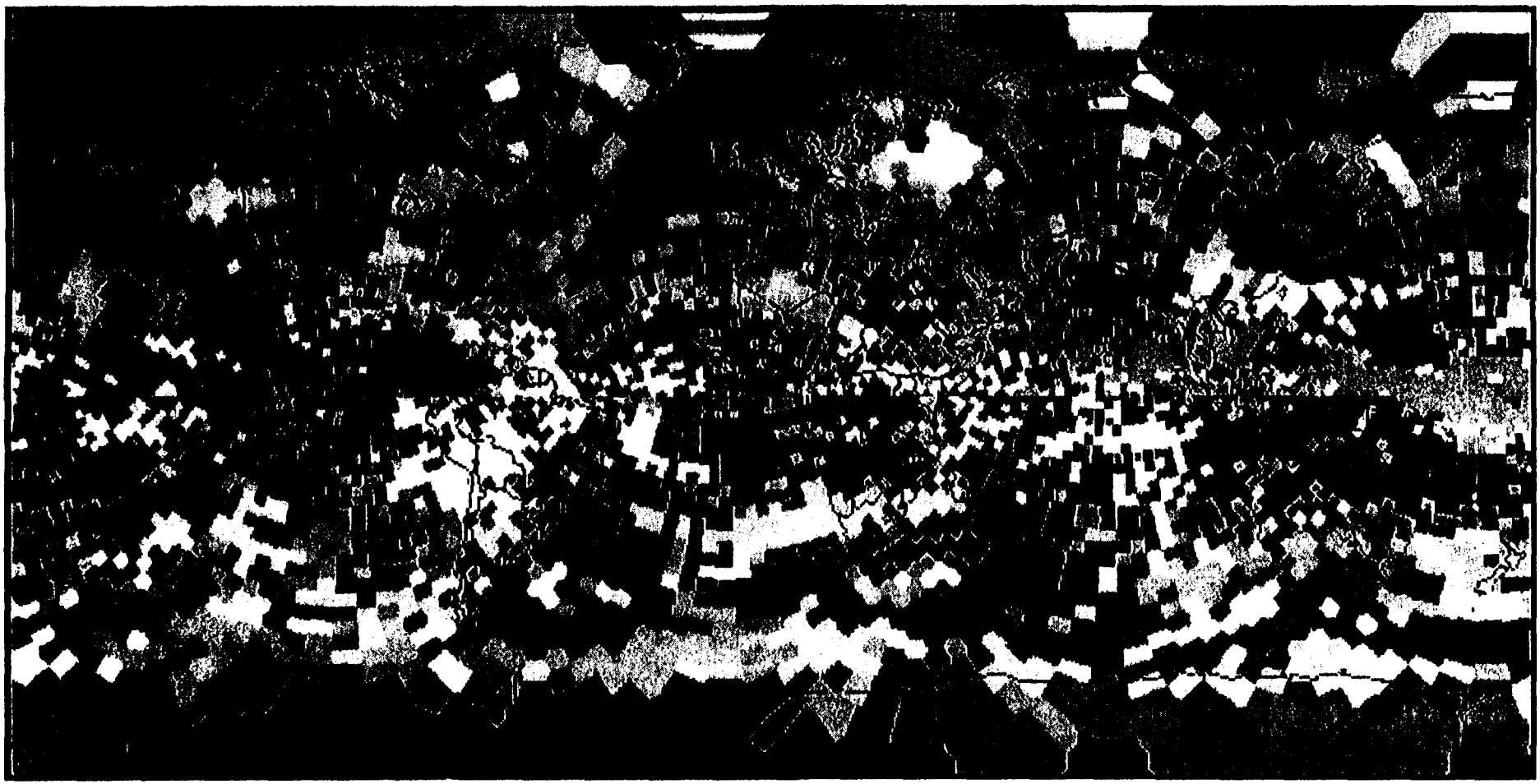
MAY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES

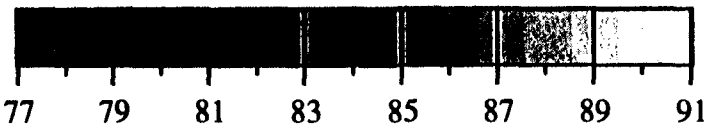


JUNE
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES

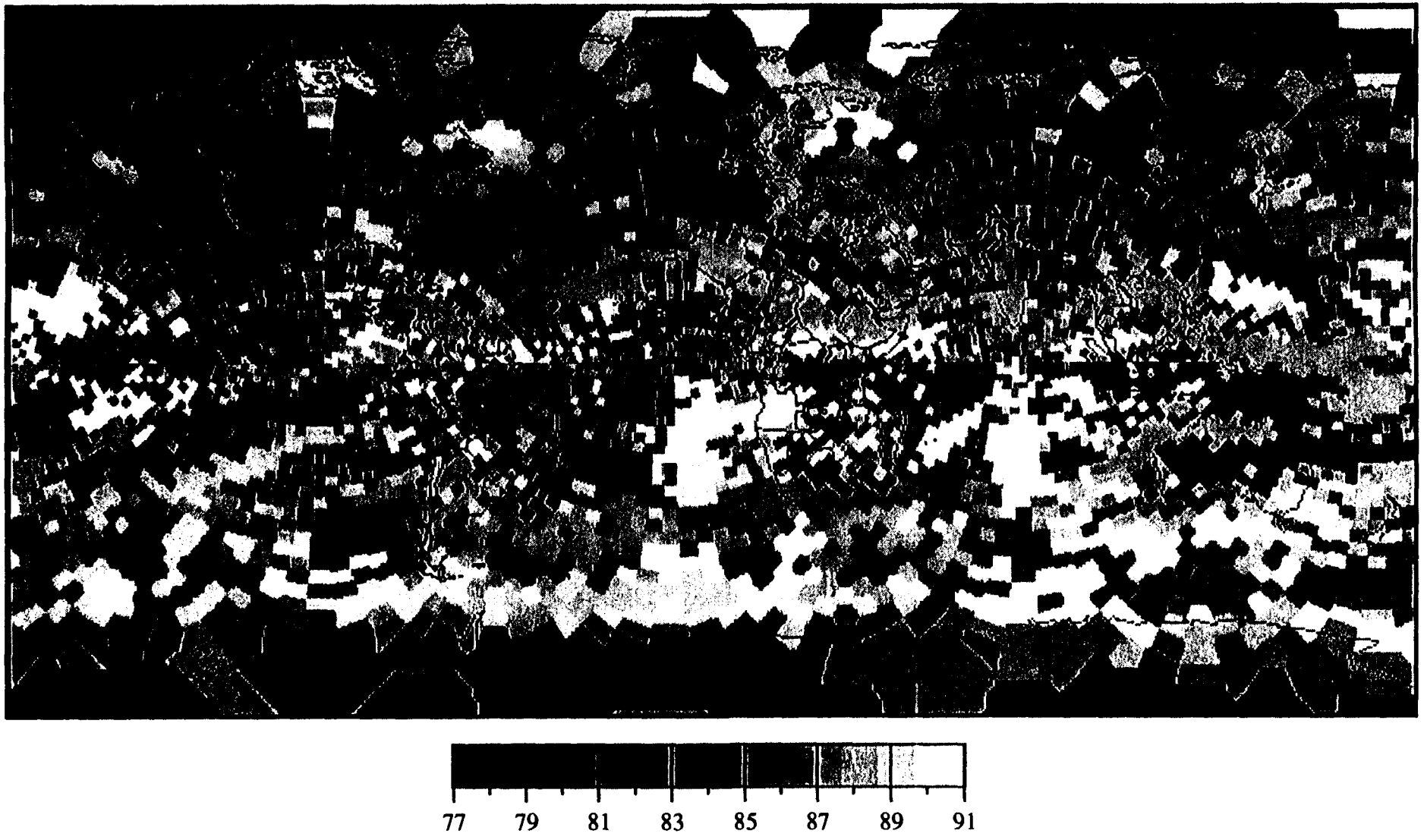


JULY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES





AUGUST
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



SEPTEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
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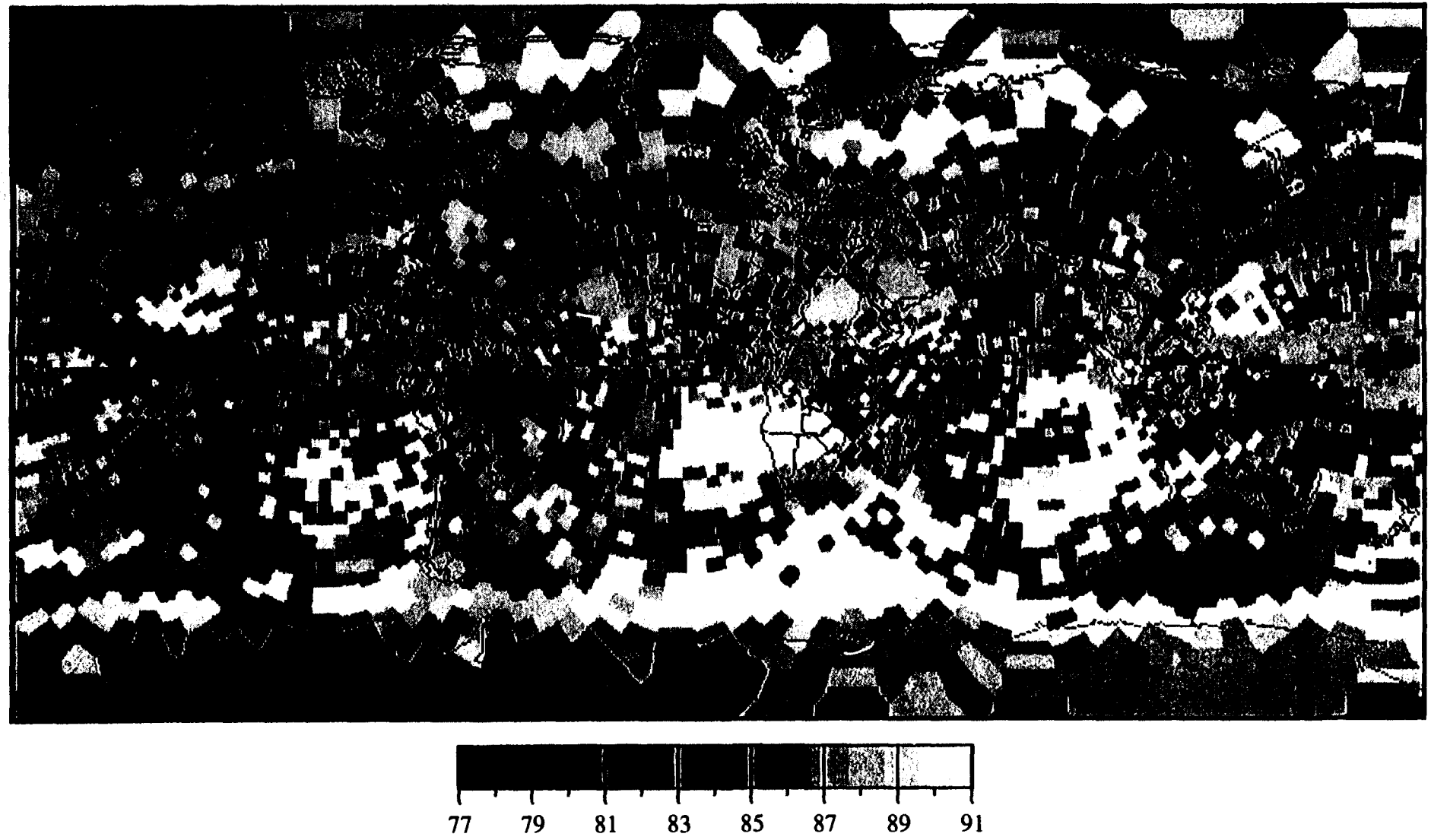

OCTOBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
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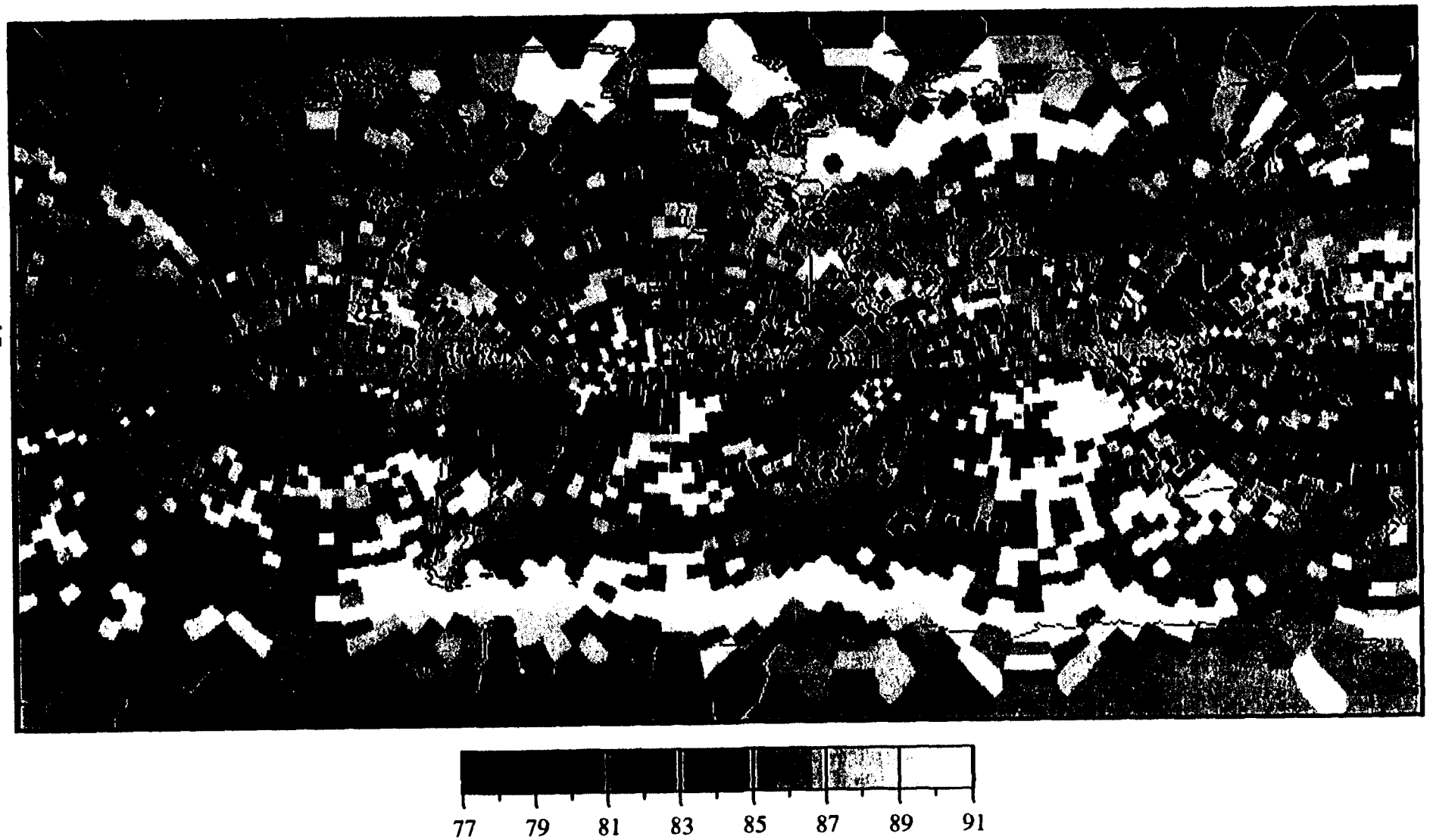

NOVEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
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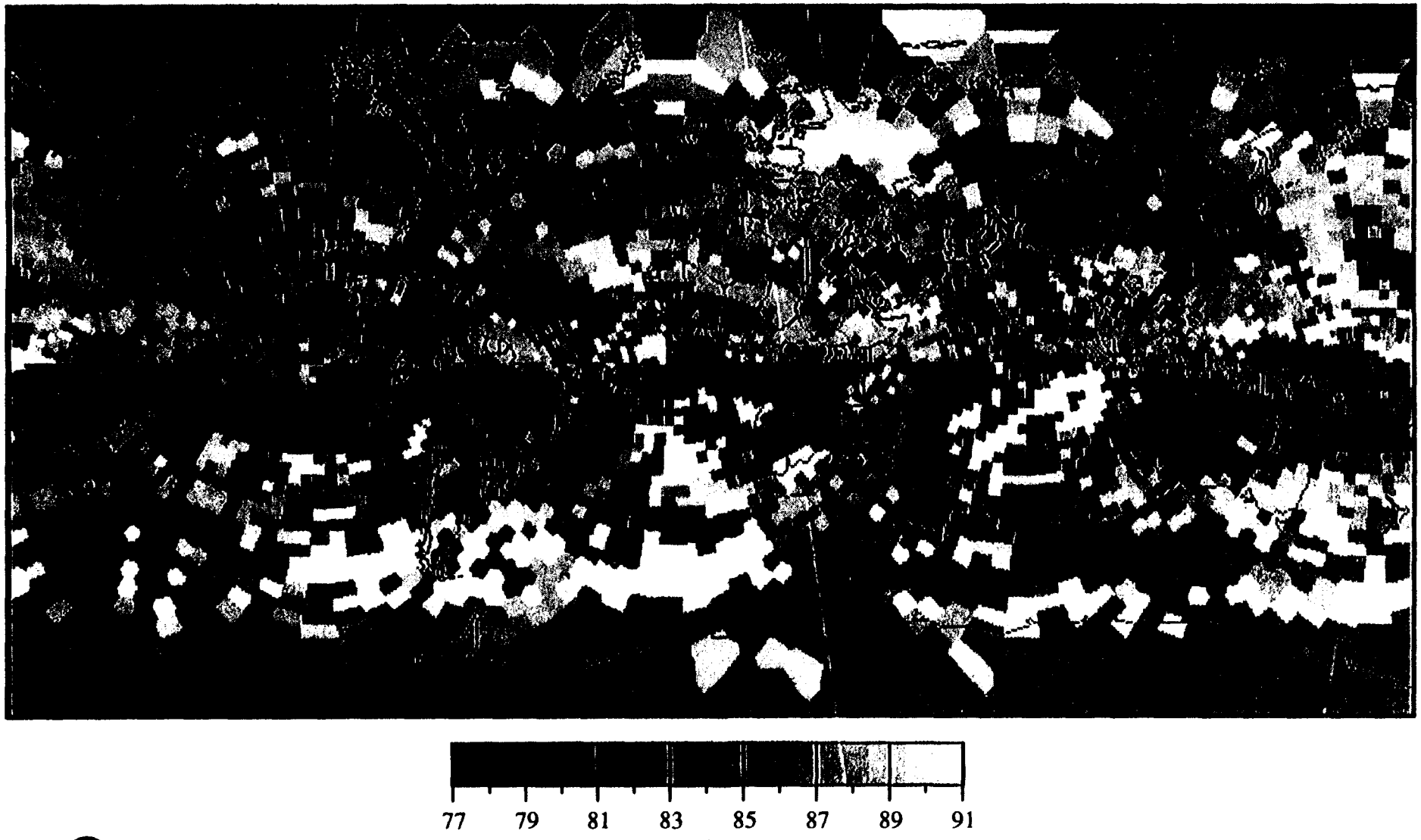

DECEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
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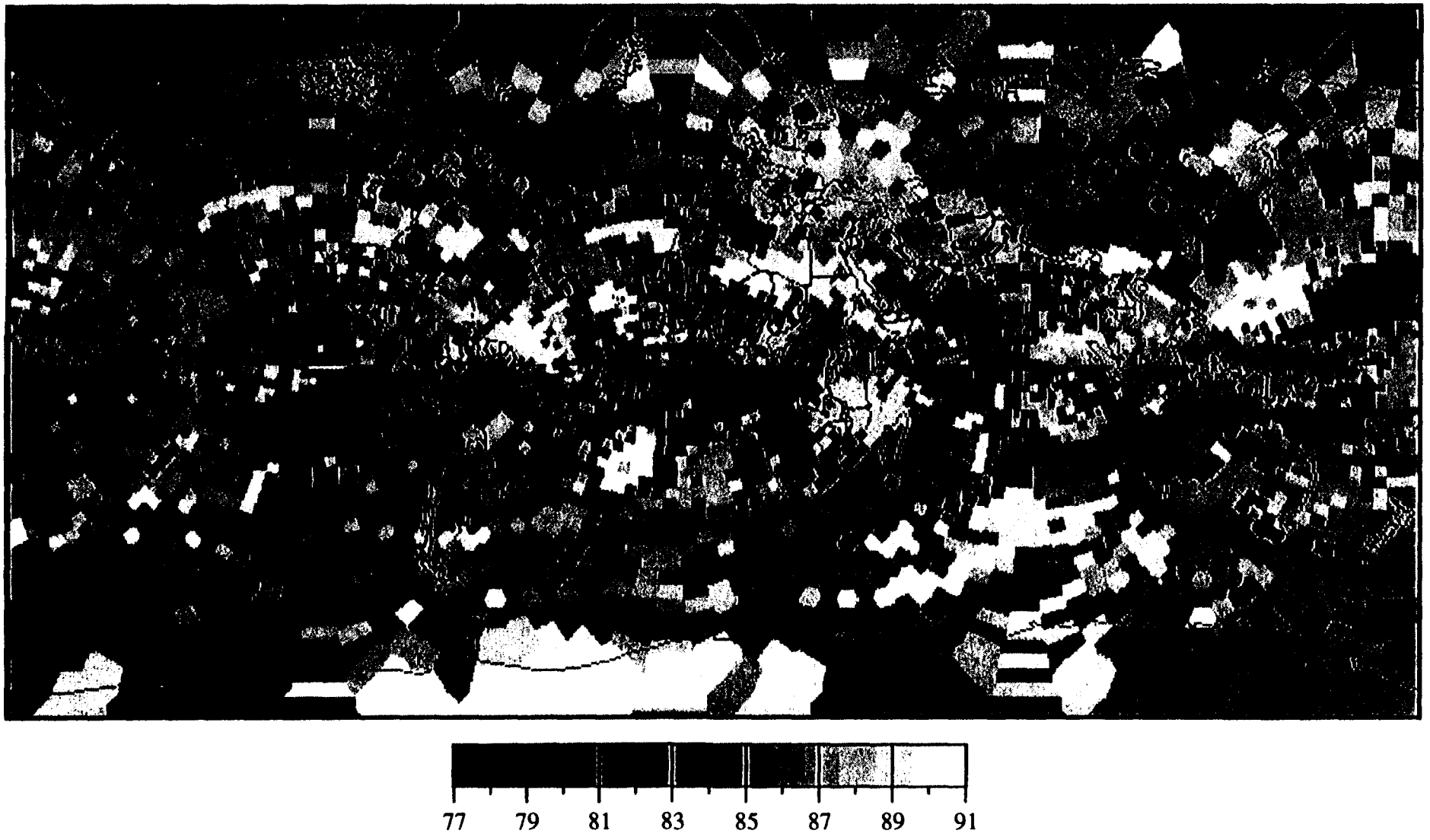

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