UNCLASSIFIED

U. S. NAVY MARINE CLIMATIC ATLAS OF THE WORLD

VOLUME IX

WORLD-WIDE MEANS AND STANDARD DEV

PREPARED BY
NAVAL OCEANOGRAPHY COMMAND DETACHMENT, ASHEVILLE, N

PREPARED FOR
COMMANDER, NAVAL OCEANOGRAPHY COMMAND
NSTL STATION, BAY ST. LOUIS, MS 39529

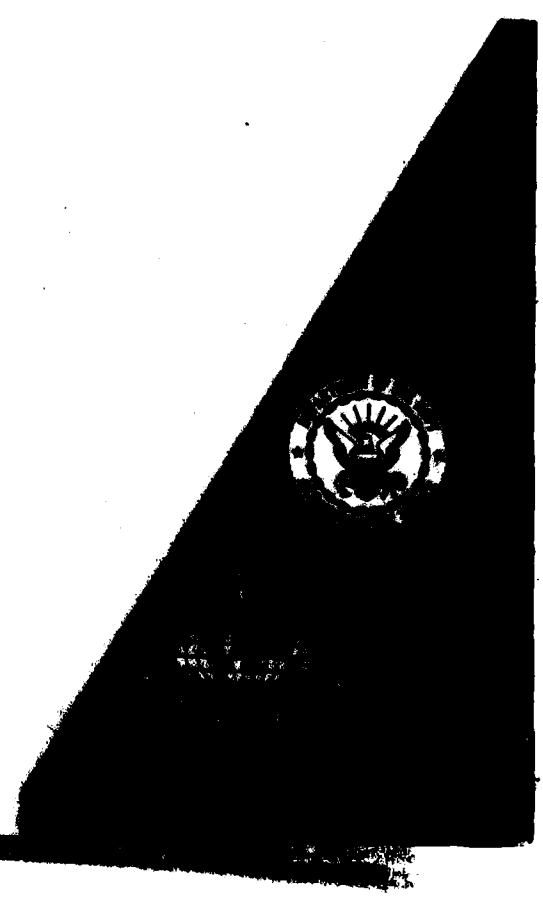
NAVAIR 50-1C-65

LD

RD DEVIATIONS

SHEVILLE, N.C.

MAND



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

The eight volume series of the U.S. Navy Marine Climatic Atlas of the World has had world-wide acceptance as an authoritative reference for large scale operational planning and applied research. This volume, based on the entire period of record available, resulted from the need to develop an automated quality control scheme for marine observations for use in the revision of the first 5 volumes of Atlas series. This was basically achieved by summarizing, analyzing and digitizing the mean and standard deviation charts that appear in this volume.

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MAY 1981

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PHY COMMAND

MENT PRINTING OFFICE, WASHINGTON D.C. 20402

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FOREWORD

The Naval Oceanography Command Detachment (NOCD), Asheville, NC, pursued the idea of producing a world atlas after the first five volumes of U.S. Navy Marine Climatic Atlas of the World had been revised. At the same time both NOCD and the National Climatic Center were interested in developing an automated quality control scheme for marine observations. This called for a data base of quality long-term global means and some measure of variability. Both these tasks were basically achieved by summarizing, analyzing and digitizing the mean and standard deviation charts that appear in this volume. The data used were derived primarily from the Marine Atlas project. The initial summary work was performed for application to this atlas and Defense Mapping Agency Pilot Charts.

ACKNOWLEDGEMENTS

This volume was prepared by direction of the Commander, Naval Oceanography Command and coordinated by the Naval Oceanography Command Detachment, Asheville, NC. Work was performed by the National Climatic Center.

Specific acknowledgment is made to members of the National Climatic Center: project leaders Messrs. J.D. Elms (Chief Analyst) and R.G. Quayle; Mr. Fred Doehring for his assistance in the analyses and quality control; Ms. I.S. Lewis and Mr. D.G. Marshbanks for their supervision of digitizing the charts; Messrs. M.G. Burgin and R.H. Courtney for technical work.

Thanks are also given to Dr. H.L. Crutcher, consulting meteorologist, for his assistance with the air temperature and dew point charts.

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TABLE OF CONTENTS

* ISOPLETH ANALYSES PRESENTED FOR BOTH LAND AND SEA.

TABLE OF CONTENTS

OR BOTH LAND AND SEA.

INTRODUCTION

The eight volumes of the series U.S. Navy Marine Climatic Atlas of the World, which were produced in the late 1950's and early 1960's, have had wide acceptance as an authoritative reference for large scale operational planning and applied research. In 1969 a feasibility study was undertaken by the Naval Weather Service Command and the Naval Oceanographic Office which led to the revision of the first five volumes of the series (North Atlantic, Vol. I, 1974; North Pacific, Vol. II, 1977; Indian Ocean, Vol. III, 1976; South Atlantic, Vol. IV, 1978; South Pacific, Vol. V, 1979). Before the revision began, an indepth review and validation of existing data were performed. Historical marine observations collected over more than 120 years by many nations were converted to a common magnetic tape format and utilized for the atlases. As each volume was revised, contemporary data were added to the historical data. The resulting data set was designated the Marine Atlas File.

Upon revision of the first five volumes it was determined that there was an insufficient increase in observations in the polar regions to warrant revising Volumes VI (Arctic Ocean, 1963) and VII (Antarctic, 1965). However, as a final step in the atlas project, data from the five atlas files plus data from the polar regions (all that the National Climatic Center had been able to collect through the late 1970's) were brought together to produce charts of the world oceans. The texts of the first five volumes may be referenced for more insight into the data sources and processing techniques.

THE INDIVIDUAL CHARTS

Detailed global analyses of long-term monthly climatological means and standard deviations were performed for the following elements:

1. Atmospheric Pressure
2. Surface Air Temperature
3. Surface Dew-Point Temperature
4. Sea Surface Temperature
5. Air-Sea Temperature Difference
6. Ocean Wave Height (higher of sea or swell)
7. Wind Speed

The climatic data (means, standard deviations, and observation counts) were plotted for each five-degree quadrangle onto an 80 X 107 cm Miller cylindrical projection of the world. These climatic maps were then carefully analyzed and manually adjusted for continuity and consistency. In many regions (coastal areas, ocean currents, etc.) where the five-degree resolution was not adequate, the individual atlas basin maps were referenced for one- and two-degree resolution. Ocean analyses were based solely on marine observations. The analyses over land of means of pressure, air temperature, and dew point were adapted from existing publications (annotated with an asterisk in the bibliography). These land analyses were included to provide continuity and to show general global patterns. Since they were adapted from publications with a variety of map projections and resolutions, it is likely that some detail was lost in the transposition. If highly accurate detail is needed over specific land locations, individual station summaries or other references should be consulted (see the bibliography).

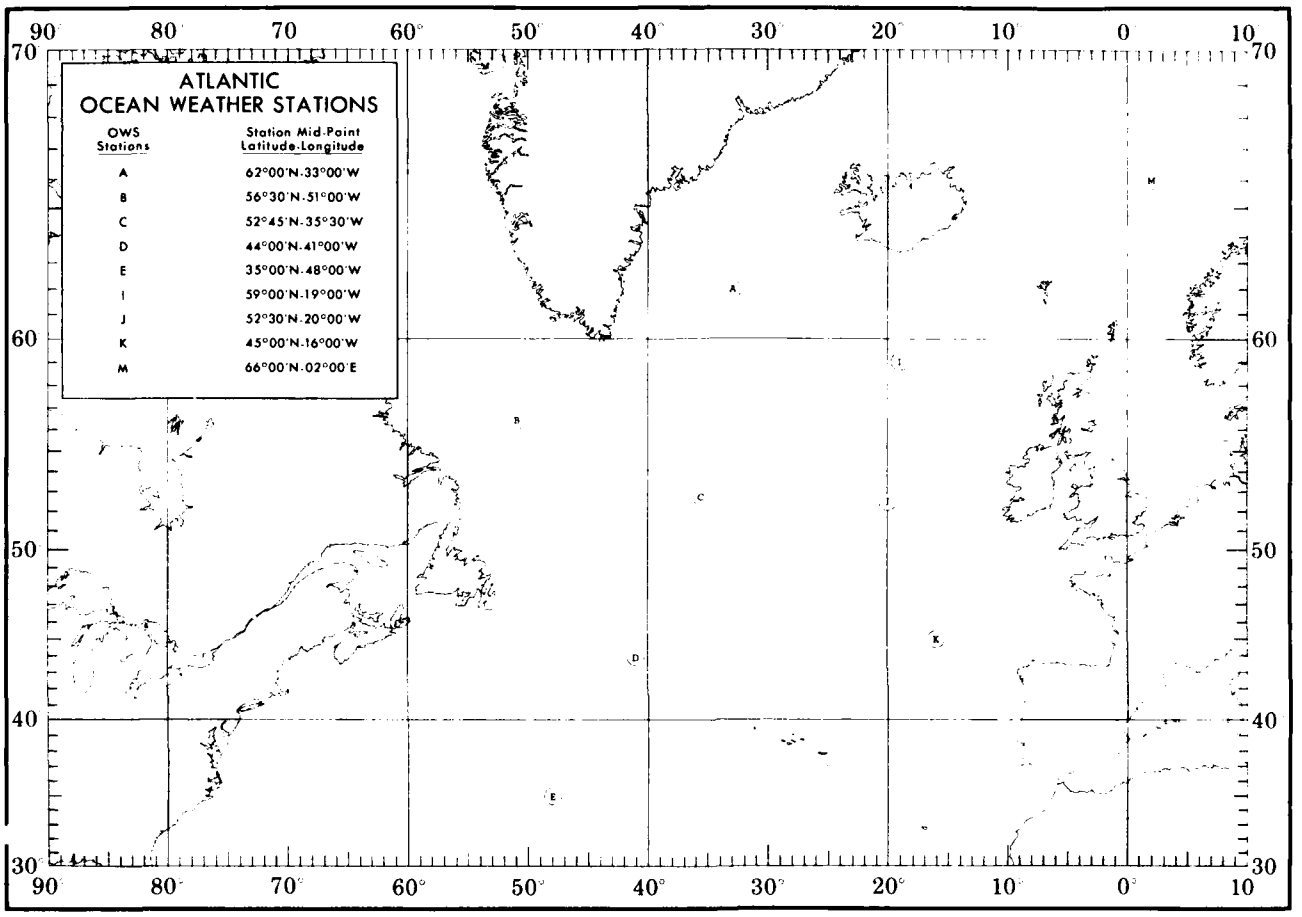
Each chart was digitized with all inflection points and singularities identified. This was done from pole to pole and the results plotted to the original scale for quality control. Once the quality was assured, the charts were plotted at a reduced scale from 80 degrees north to 80 degrees south for this publication. If required, this digital data set can be converted into a global one-degree (or other grid mesh) grid for improvement of various climate models, quality control programs and data base systems.

The individual charts are self-explanatory. The means and standard deviations are presented by isopleths (lines connecting points of equal magnitude). The standard deviations are provided to give a measure of relative variability of each element. The standard deviations were computed for each five-degree area using the following expression:

$$S = \left[\frac{N\Sigma X_i^2 - (\Sigma X_i)^2}{N(N-1)} \right]^{1/2}$$

where N is the number of observations in the sample and X_i is the ith realization of the random variable X. The use of (N-1) in the denominator gives the best estimate of the population standard deviations. The means, $\bar{X}$, are computed from:

$$\bar{X} = \Sigma X_i / N$$


ATLANTIC
OCEAN WEATHER STATIONS
OWS Stations
Station Mid-Point Latitude-Longitude
A 62°00'N-33°00'W
B 56°30'N-51°00'W
C 52°45'N-35°30'W
D 44°00'N-41°00'W
E 35°00'N-48°00'W
I 59°00'N-19°00'W
J 52°30'N-20°00'W
K 45°00'N-16°00'W
M 66°00'N-02°00'E
90 80 70 60 50 40 30 20 10 0 10
70 60 50 40 30

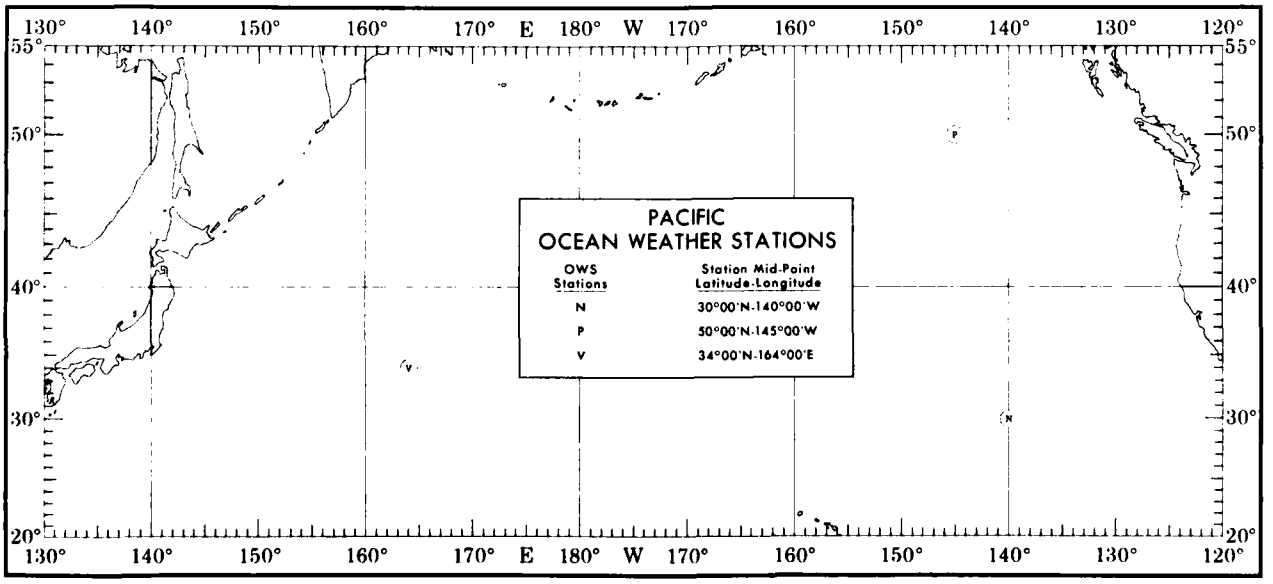

PACIFIC
OCEAN WEATHER STATIONS
OWS Stations
Station Mid-Point Latitude-Longitude
N 30°00'N-140°00'W
P 50°00'N-145°00'W
V 34°00'N-164°00'E
130° 140° 150° 160° 170° E 180° W 170° 160° 150° 140° 130° 120°
55° 50° 40° 30° 20°

Fig. 1

One should keep in mind that the standard deviation, the square root of the second moment about the mean, is merely an arithmetic function that gives an objective measure of dispersion or variability. For data that are approximately normally distributed, the mean plus or minus certain multiples of the standard deviation will result in objective estimates of the probability of encountering various ranges of the variable. Approximately 34.1 percent of the values can be expected to fall between $\bar{X}$ and $\bar{X}$ + 1S, 13.6 percent between $\bar{X}$ + 1S and $\bar{X}$ + 2S and 2.1 percent between $\bar{X}$ + 2S and $\bar{X}$ + 3S. A mirror image is found on the negative side of the mean. Elements such as pressure, air temperature, sea surface temperature (in areas where freezing does not present a lower bound), air-sea temperature differences, and dew point can usually be described by the normal distribution. Useful objective approximations of variability can also be determined for wind speed and wave height, but negative (impossible) values and other non-normalities in the distributions will render the standard deviations of these elements far less useful than for other elements. The same is sometimes true of sea surface temperature, particularly in very cold areas.

An important property of the means and standard deviations shown in this atlas is that they were computed from all ship observations within a five-degree quadrangle over the entire period of available data. Misinterpretation may result if the possible consequences of this procedure are not carefully considered. Specifically:

1. Stationarity (no significant trends in the data) must be assumed where different areas contain data from different periods of record. This was tested on several samples and it was determined that there were no operationally significant trends. Operationally significant accuracies for most climatic applications were considered to be:

Temperatures	± 1°C
Pressure	± 1 mb
Wind Speeds	± 3 Kts or 10%, whichever is greater
Wave Heights	± .5 m

2. Inhomogeneity among various data sources appeared to be a relatively greater problem than stationarity. It was solved through empirical adjustment or deletion of inhomogeneous data sets.

3. Data over an entire month were considered, without regard to the day of the month. Thus, if all data from one area were clustered at the beginning of the month, while data from another area were clustered at the end of the month, a potential bias could result. On the average these problems were not operationally significant. The same sort of bias could occur from sampling only selected hours of the day. Again, the problems were not operationally significant.

4. Data were accumulated for five-degree areas. For different latitudes, and in coastal areas, five-degree quadrangles represent different geographical areas (as measured in square miles). Use of the centroid of the marine area as the assumed locus of the element being analyzed was appropriate in most instances. Where this was not true, earlier atlas charts drawn from one-degree and two-degree plots were used for guidance. However, the standard deviations presented a special problem, as they represented not only the point variability (for each point within the five-degree areas), but also the areal variability (caused by gradients of the variables across the areas).

Despite these problems, the resulting charts proved t accurate when compared objectively to the only climatological data available over the oceans - the Stations (OWSs). The OWS network data base (see I created through the cooperation of several maritime nati three decades. Locations are not actually fixed, but va the ships attempt to remain close to their desi Unfortunately, many of these stations have been phas years, with only a few being replaced by buoys. In orde independently analyzed charts with data from OWSs, me deviations were computed for the OWSs and compared interpolated from the five-degree charts. Linear regres performed for an objective comparison. The correla indicate that a strong linear relationship exists for al standard deviations. The results are shown in Fig. 2 linear correlation coefficient (r) appears in the upper r Zero can be interpreted as no linear correlation and correlation. The percentage of variability described regression (an indication of "goodness of fit") is equa However, this is not indicative of how close the analyz the point source data. That relationship is a function intercept values. Results show that the means are in but the standard deviations vary considerably from poin depending largely upon geography and climate. However, point standard deviations can be estimated from the ma some degree of confidence. To approximate a point stan mean empirically from the maps and Fig. 2, multiply value from the map by the slope (a_1) and add the sig intercept (a_0), or simply perform the operations graphica

In areas where the analyst felt that the gradient w maintain visual separation of isopleths after reduction, s were omitted. This occurred mainly in the higher latitu areas and near the ice limit. Also, because of the gra the isopleths were more limited than over water.

Since the mean ice limit approximates the minus two de temperature isopleth, this analyzed lower limit was boundary for the waves and air-sea temperature differen also keep in mind that when using the wave height chart or swell), combined sea wave and swell values may higher. In order to make the air-sea temperature d agree with the mean air and mean sea temperature char were derived graphically. This restricted the resolution Celsius.

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result in objective estimates of
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areas where freezing does not
ature differences, and dew point
l distribution. Useful objective
e determined for wind speed and
lues and other non-normalities in
deviations of these elements far
e same is sometimes true of sea
old areas.

standard deviations shown in this
all ship observations within a
ire period of available data.
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Specifically:

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data sources appeared to be a
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mogeneous data sets.

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from another area were clustered
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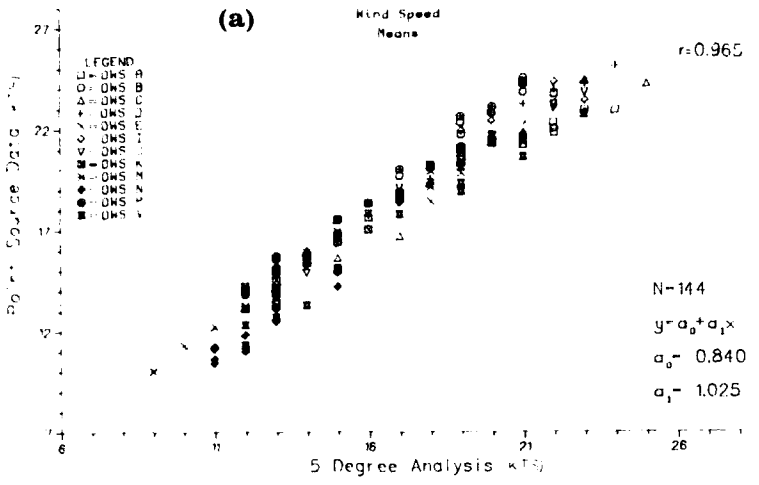
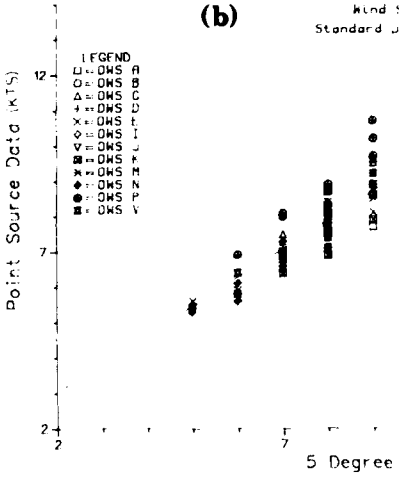
ed in square miles). Use of the
sumed locus of the element being
nces. Where this was not true,
egree and two-degree plots were
ard deviations presented a special
e point variability (for each point
the areal variability (caused by
eas).

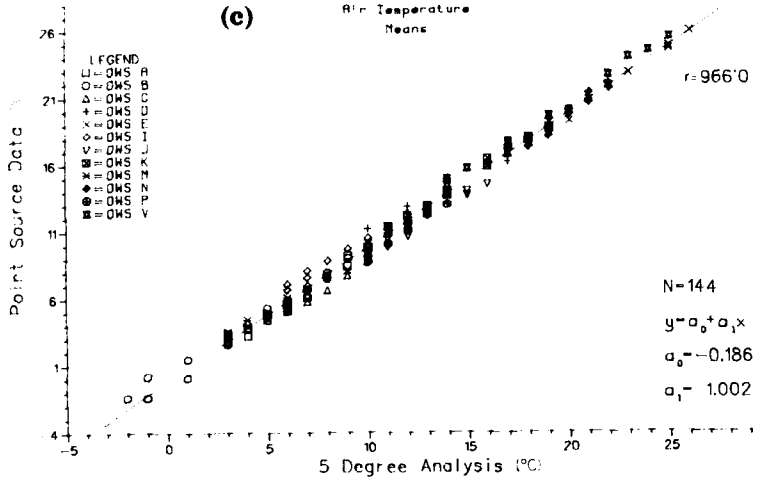
Despite these problems, the resulting charts proved to be surprisingly accurate when compared objectively to the only long-term point climatological data available over the oceans - the Ocean Weather Stations (OWSs). The OWS network data base (see Fig. 1) has been created through the cooperation of several maritime nations over the past three decades. Locations are not actually fixed, but vary very little, as the ships attempt to remain close to their designated positions. Unfortunately, many of these stations have been phased out in recent years, with only a few being replaced by buoys. In order to compare the independently analyzed charts with data from OWSs, means and standard deviations were computed for the OWSs and compared to those values interpolated from the five-degree charts. Linear regression analysis was performed for an objective comparison. The correlation coefficients indicate that a strong linear relationship exists for all the means and standard deviations. The results are shown in Fig. 2 a-n, where the linear correlation coefficient (r) appears in the upper right hand corner. Zero can be interpreted as no linear correlation and one as perfect correlation. The percentage of variability described by the linear regression (an indication of "goodness of fit") is equal to $r^2 \times 100$. However, this is not indicative of how close the analyzed values are to the point source data. That relationship is a function of the slope and intercept values. Results show that the means are in close agreement, but the standard deviations vary considerably from point-source values, depending largely upon geography and climate. However, it appears that point standard deviations can be estimated from the mapped values with some degree of confidence. To approximate a point standard deviation or mean empirically from the maps and Fig. 2, multiply the five-degree value from the map by the slope (a_1) and add the signed value of the intercept (a_0), or simply perform the operations graphically.

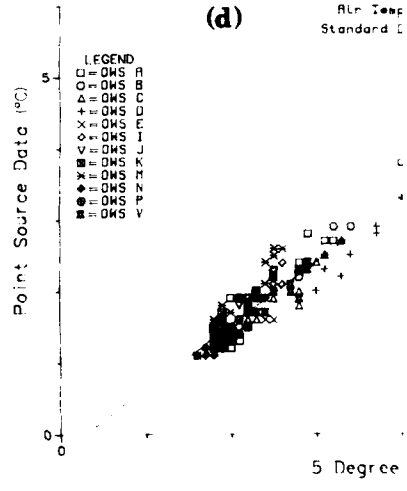
In areas where the analyst felt that the gradient was too tight to maintain visual separation of isopleths after reduction, selected isopleths were omitted. This occurred mainly in the higher latitudes near coastal areas and near the ice limit. Also, because of the gradient over land, the isopleths were more limited than over water.

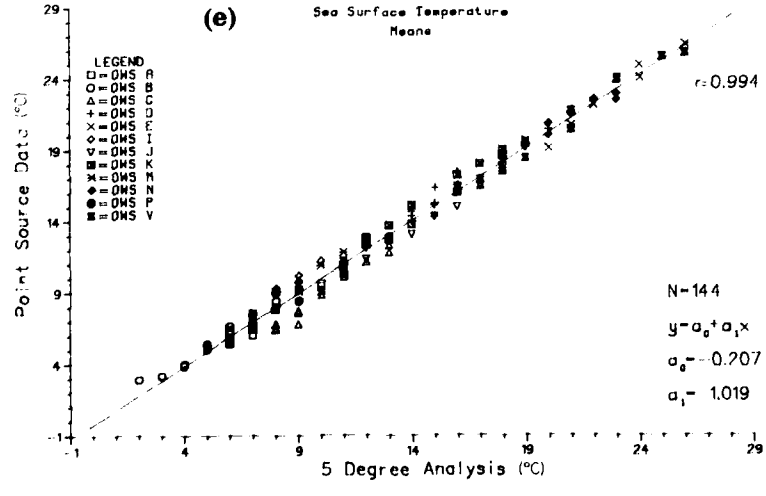
Since the mean ice limit approximates the minus two degree Celsius sea temperature isopleth, this analyzed lower limit was adopted as the boundary for the waves and air-sea temperature differences. One should also keep in mind that when using the wave height charts (higher of sea or swell), combined sea wave and swell values may be significantly higher. In order to make the air-sea temperature difference charts agree with the mean air and mean sea temperature charts, the analyses were derived graphically. This restricted the resolution to two degrees Celsius.


(a)
Wind Speed
Means
r=0.965
N=144
$y=a_0+a_1x$
a_0= 0.840
a_1= 1.025
LEGEND
Point Source Data
5 Degree Analysis (KTS)


(b)
LEGEND
Point Source Data (KTS)
5 Degree


(c)
Air Temperature
Means
r=966'0
N=144
$y=a_0+a_1x$
a_0=-0.186
a_1= 1.002
LEGEND
Point Source Data
5 Degree Analysis (°C)


(d)
LEGEND
Point Source Data (°C)
5 Degree


(e)
Sea Surface Temperature
Means
r=0.994
N=144
$y=a_0+a_1x$
a_0=-0.207
a_1= 1.019
LEGEND
Point Source Data (°C)
5 Degree Analysis (°C)

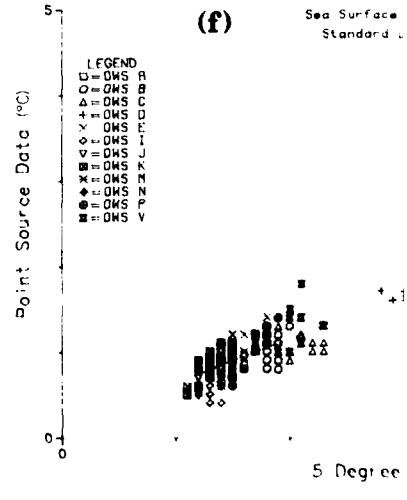

(f)
Sea Surface
LEGEND
Point Source Data (°C)
5 Degree

Fig. 2

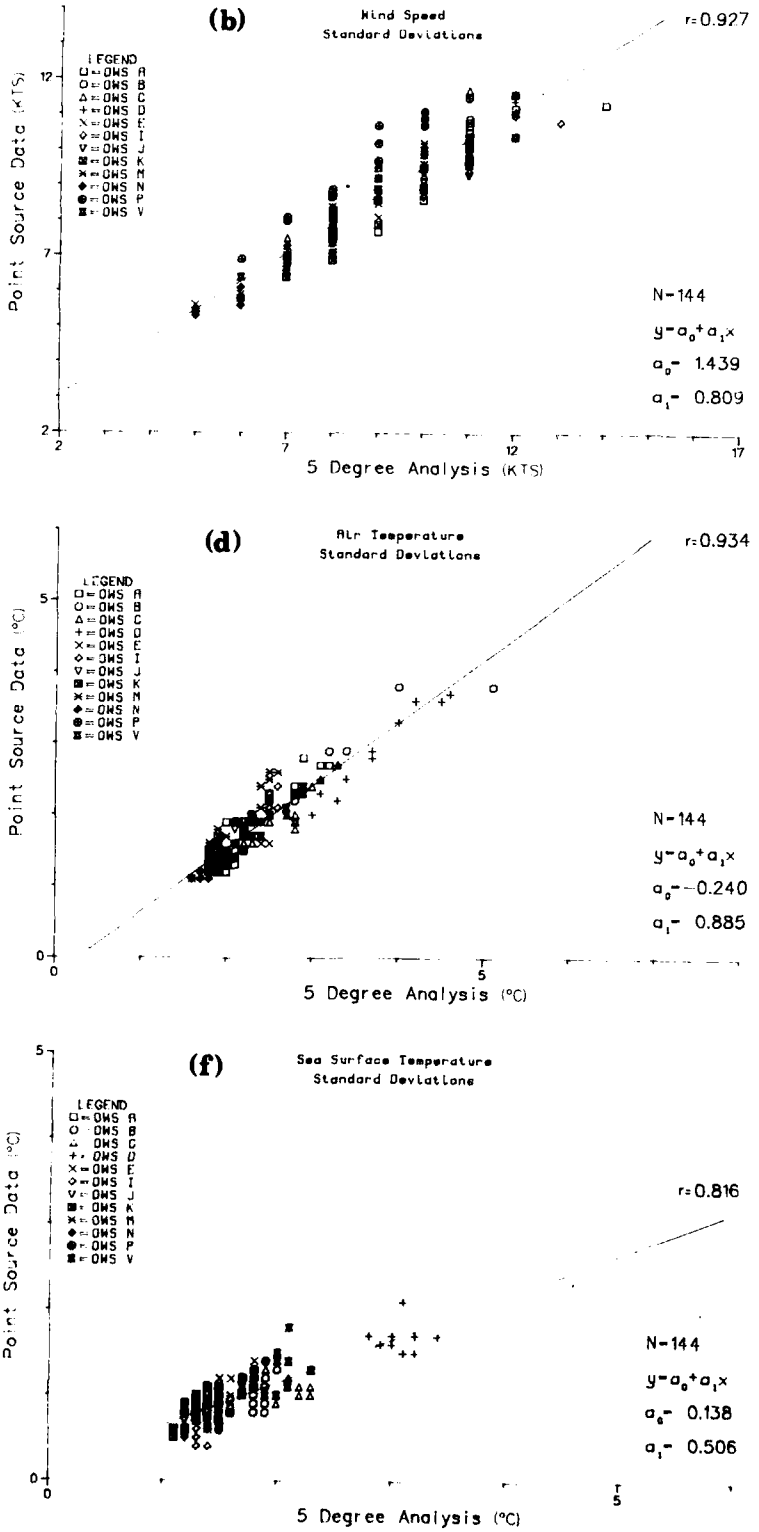

(b)
Wind Speed
Standard Deviations
r=0.927
LEGEND
OWS A
OWS B
OWS C
OWS D
OWS E
OWS I
OWS J
OWS K
OWS M
OWS N
OWS P
OWS V
Point Source Data (KTS)
5 Degree Analysis (KTS)
N=144
y=a0+a1x
a0= 1.439
a1= 0.809
(d)
Air Temperature
Standard Deviations
r=0.934
Point Source Data (°C)
5 Degree Analysis (°C)
N=144
y=a0+a1x
a0=-0.240
a1= 0.885
(f)
Sea Surface Temperature
Standard Deviations
r=0.816
Point Source Data (°C)
5 Degree Analysis (°C)
N=144
y=a0+a1x
a0= 0.138
a1= 0.506

Fig. 2

2

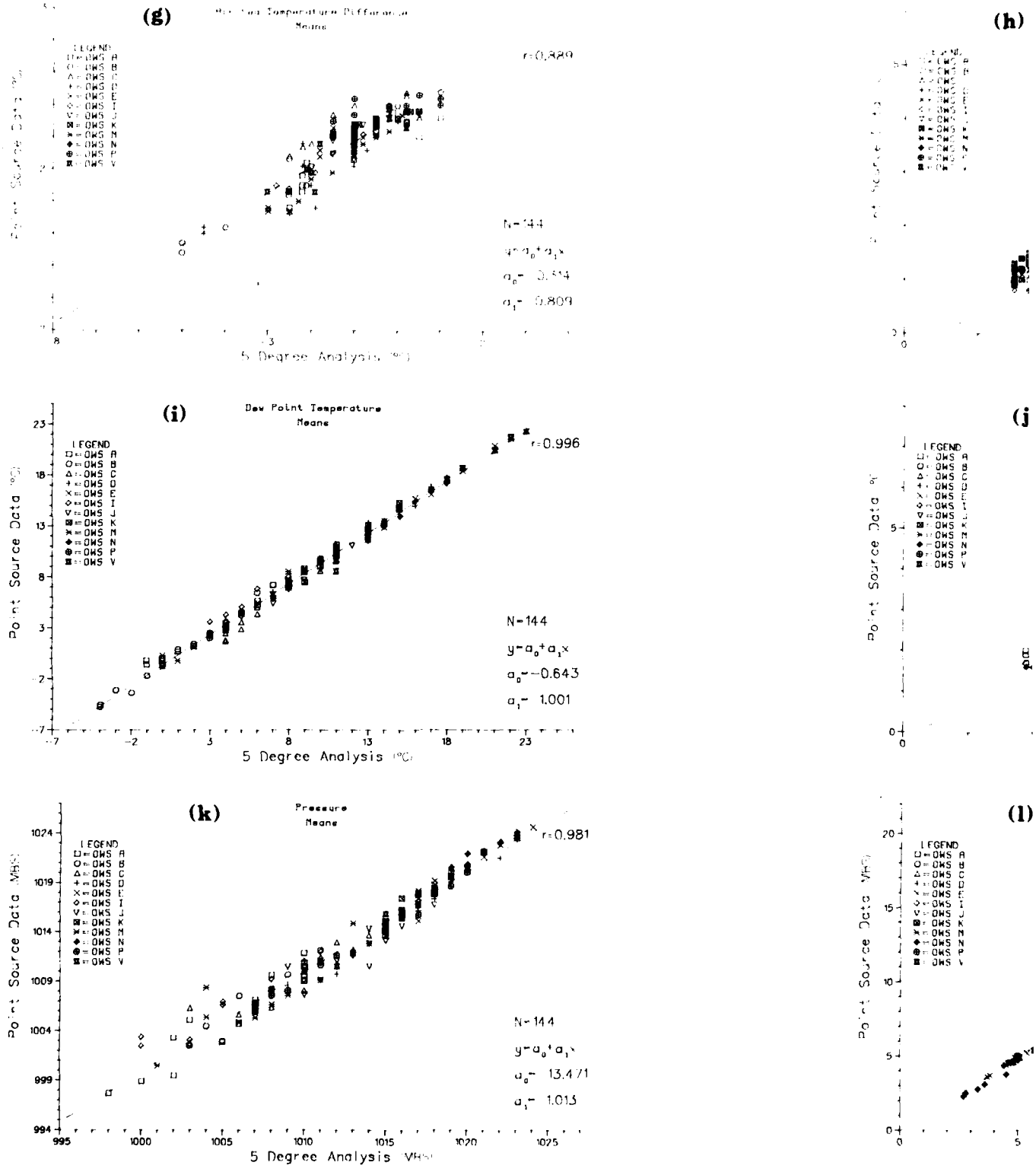
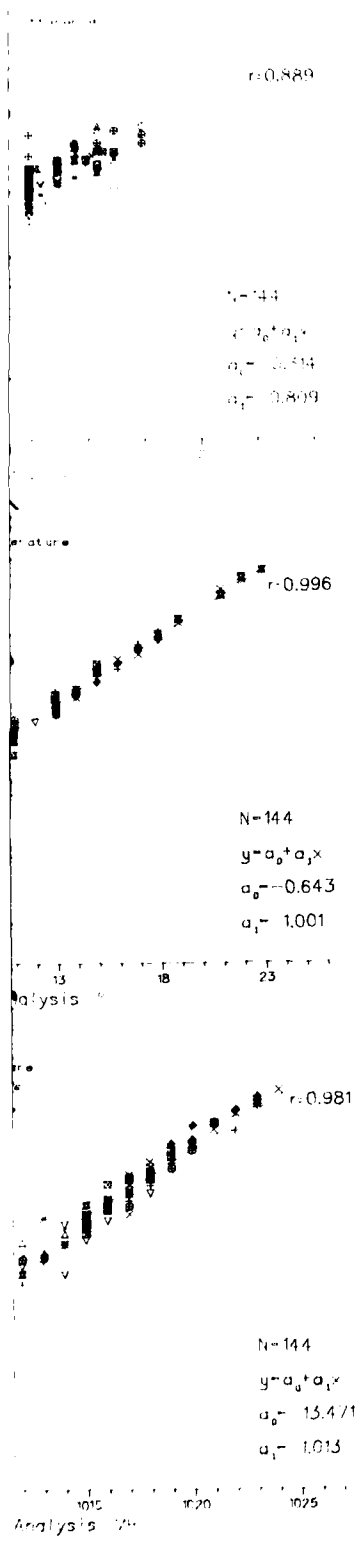

(g)
r=0.889
N=144
$y=a_0+a_1x$
a_0= 3.514
a_1= 0.809
5 Degree Analysis (°C)
(h)
(i)
Dew Point Temperature
Means
r=0.996
N=144
$y=a_0+a_1x$
a_0=-0.643
a_1= 1.001
Point Source Data (°C)
5 Degree Analysis (°C)
(j)
(k)
Pressure
Means
r=0.981
N=144
$y=a_0+a_1x$
a_0= 13.471
a_1= 1.013
Point Source Data (MB)
5 Degree Analysis (MB)
(l)
LEGEND
□=OWS A
○=OWS B
△=OWS C
+=OWS D
×=OWS E
◇=OWS I
▽=OWS J
⊠=OWS K
✱=OWS M
◆=OWS N
⊕=OWS P
■=OWS V

Fig. 2 (Cont'd)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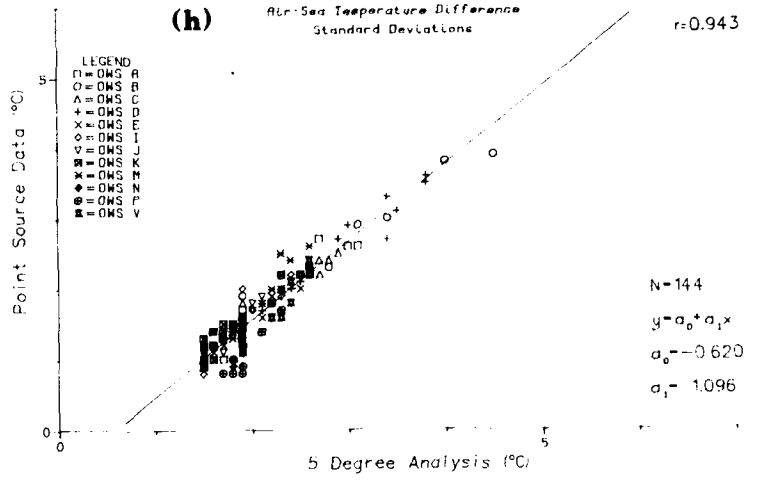
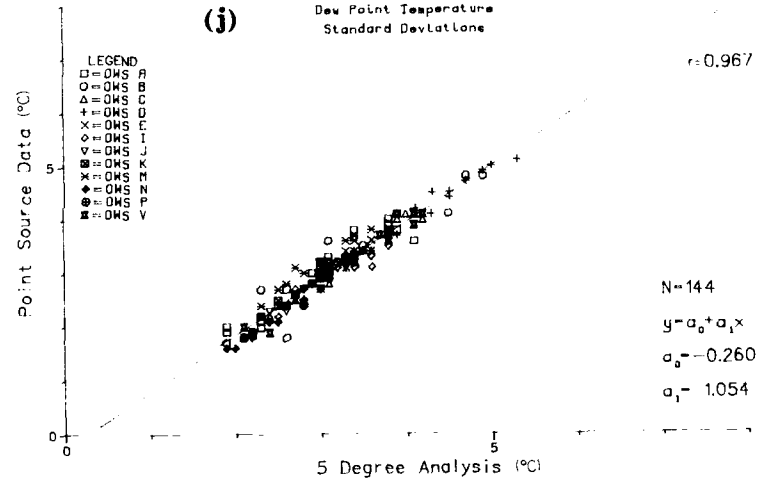
N=144
$y=a_0+a_1x$
a_0= -0.434
a_1= 0.809

r=0.996
N=144
$y=a_0+a_1x$
a_0=-0.643
a_1= 1.001
13
18
23

r=0.981
N=144
$y=a_0+a_1x$
a_0= 15.471
a_1= 1.013
1015
1020
1025


(h)
Air-Sea Temperature Difference
Standard Deviations
r=0.943
LEGEND
□=OWS A
○=OWS B
△=OWS C
+=OWS D
×=OWS E
◇=OWS I
▽=OWS J
⊠=OWS K
✕=OWS M
◆=OWS N
⊕=OWS P
▣=OWS V
Point Source Data (°C)
5 Degree Analysis (°C)
N=144
$y=a_0+a_1x$
a_0=-0.620
a_1= 1.096


(j)
Dew Point Temperature
Standard Deviations
r=0.967
LEGEND
□=OWS A
○=OWS B
△=OWS C
+=OWS D
×=OWS E
◇=OWS I
▽=OWS J
⊠=OWS K
✕=OWS M
◆=OWS N
⊕=OWS P
▣=OWS V
Point Source Data (°C)
5 Degree Analysis (°C)
N=144
$y=a_0+a_1x$
a_0=-0.260
a_1= 1.054

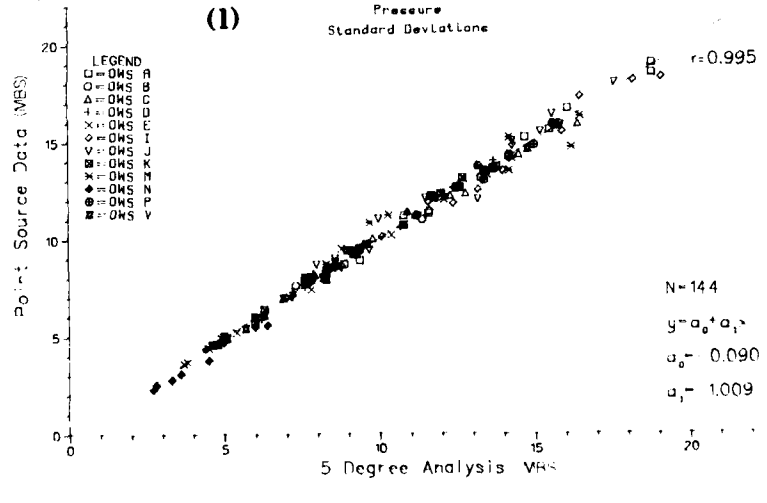
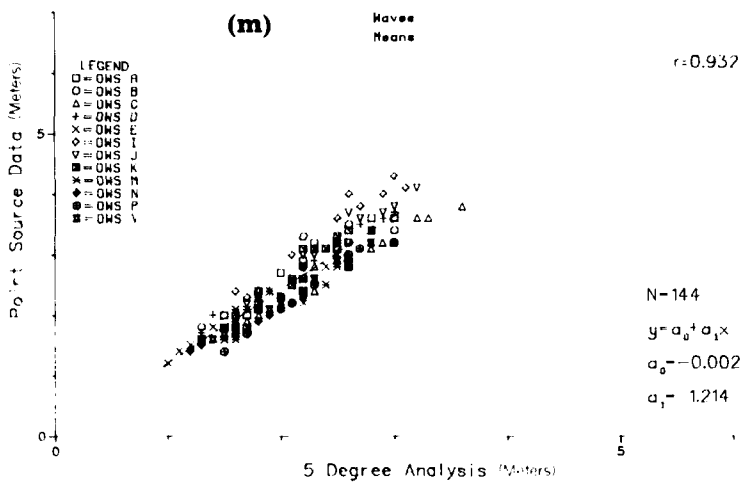

(l)
Pressure
Standard Deviations
r=0.995
LEGEND
□=OWS A
○=OWS B
△=OWS C
+=OWS D
×=OWS E
◇=OWS I
▽=OWS J
⊠=OWS K
✕=OWS M
◆=OWS N
⊕=OWS P
▣=OWS V
Point Source Data (MBS)
5 Degree Analysis MBS
N=144
$y=a_0+a_1x$
a_0= 0.090
a_1= 1.009

Fig. 2 (Cont'd)



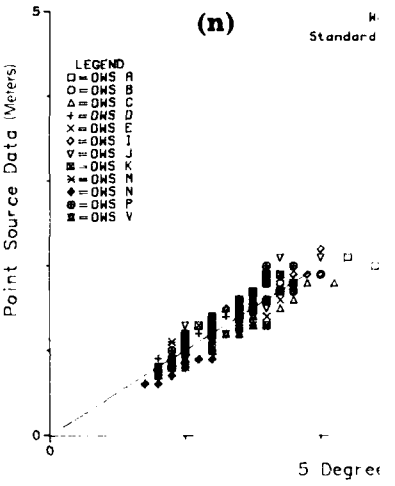


Fig. 2 (Cont'd)

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NOTE: References annotated with an asterisk (*) were consulted for adaptation of the analyses over land.

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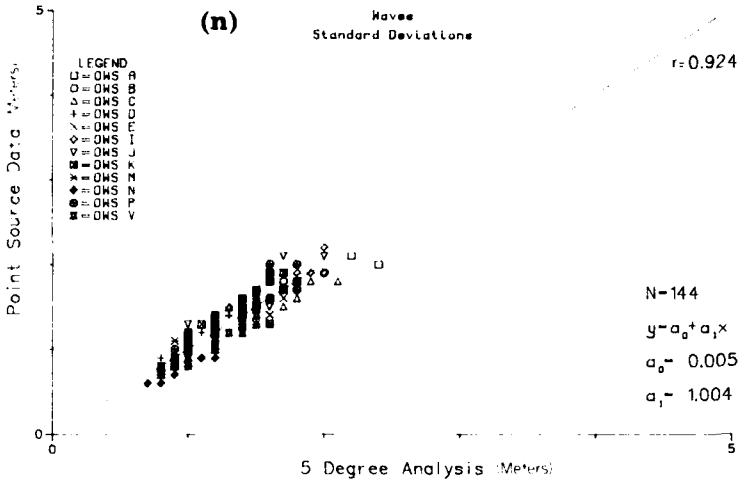

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MEANS and STANDARD DEVIATIONS

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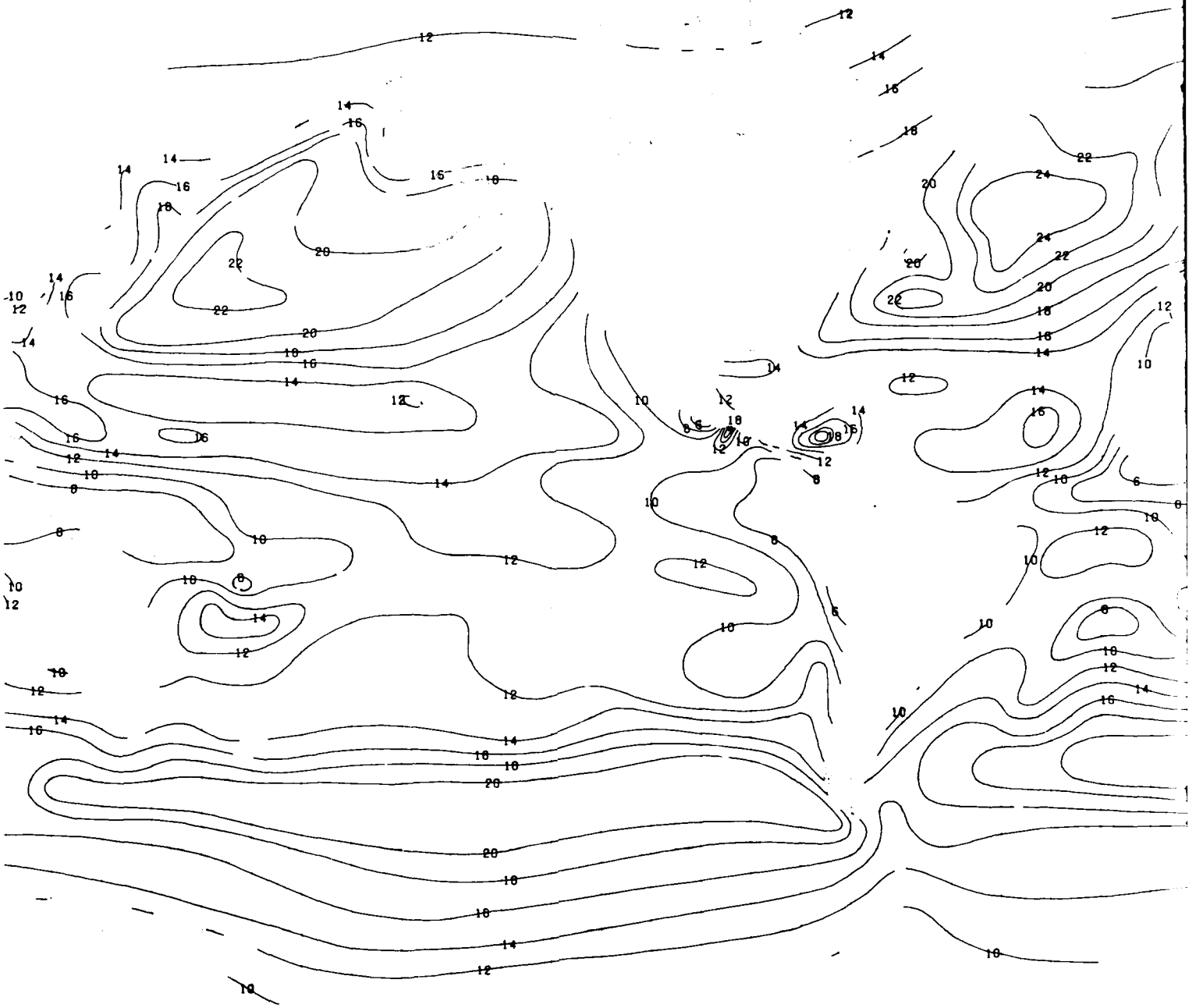

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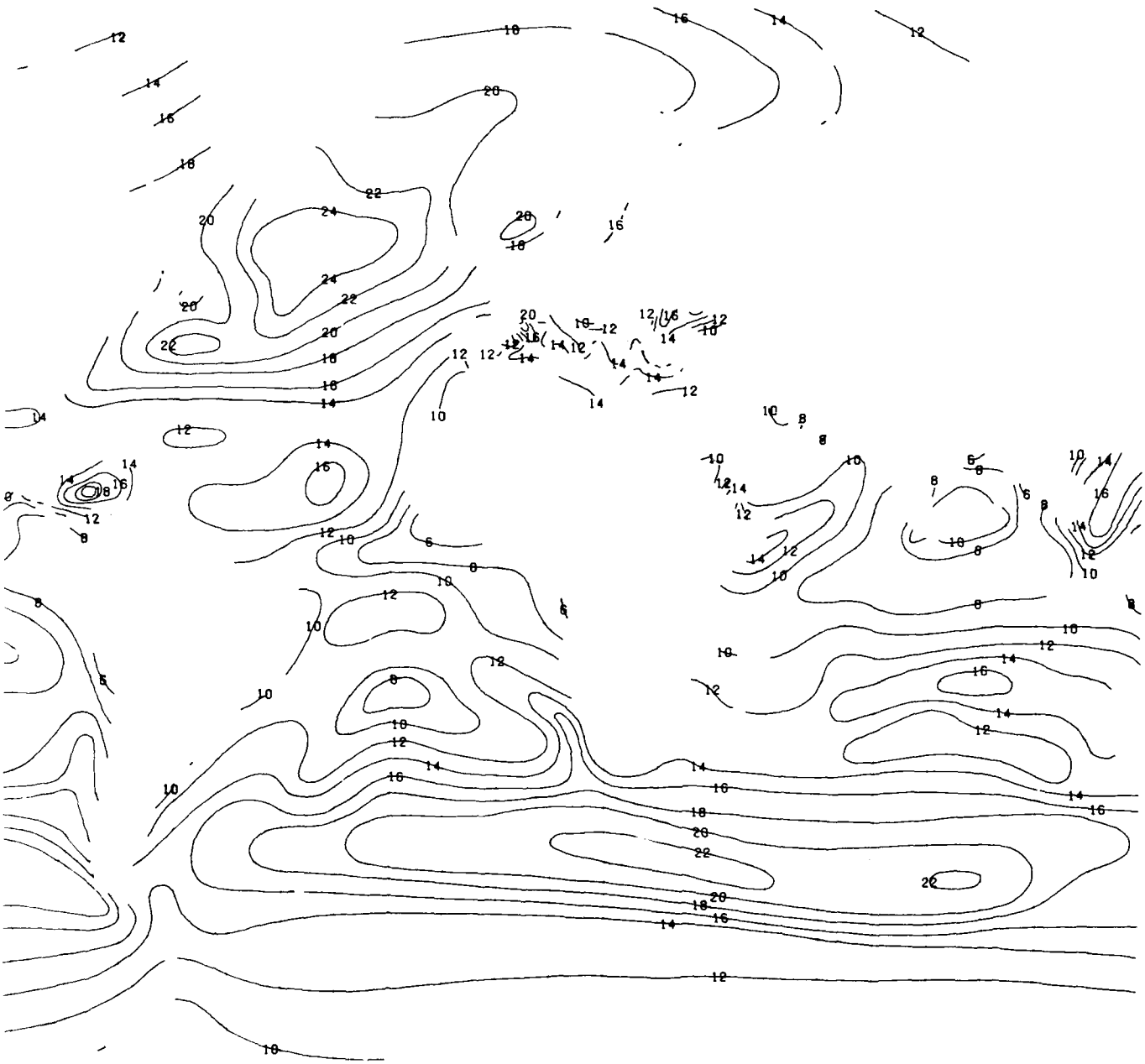

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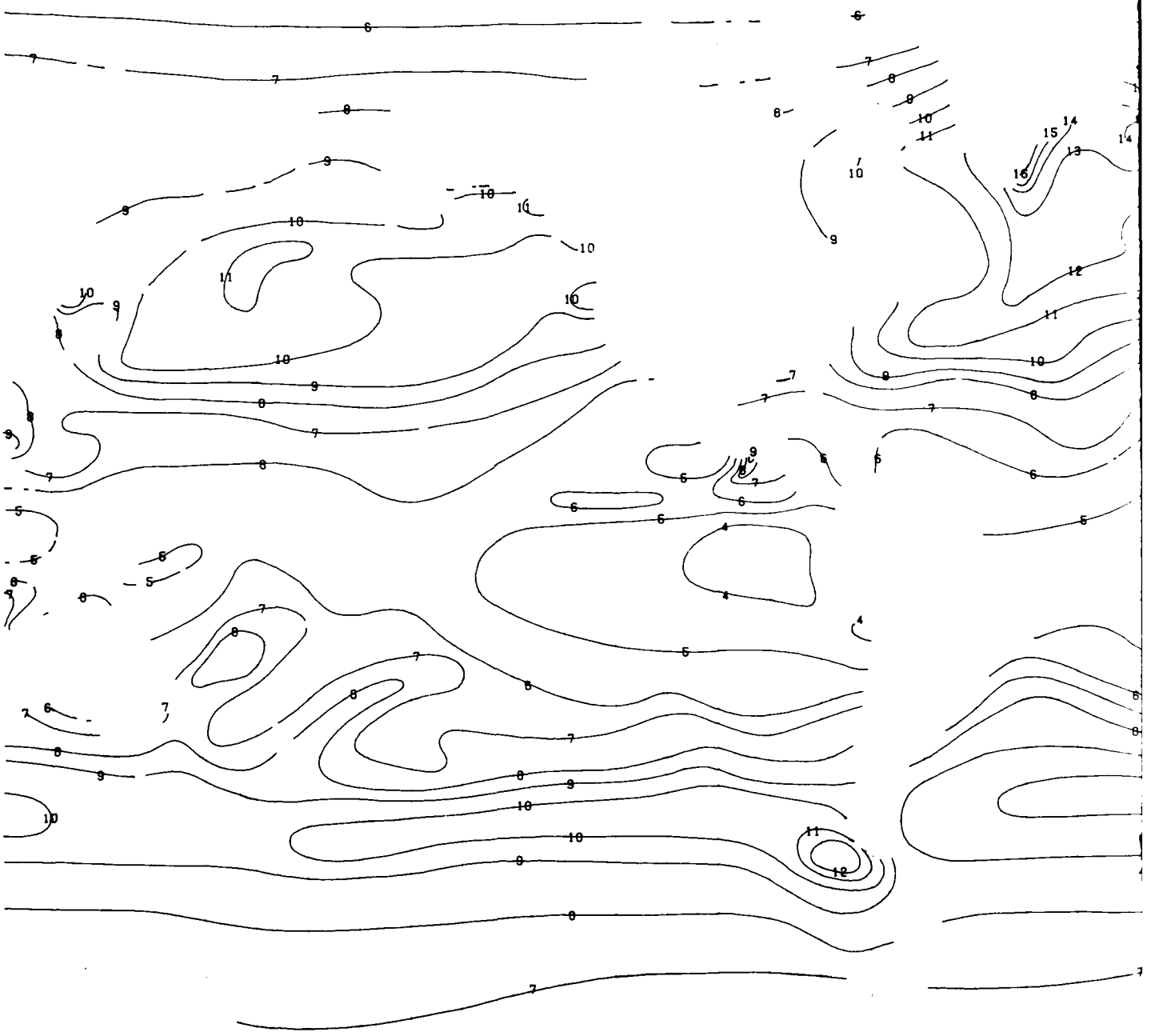

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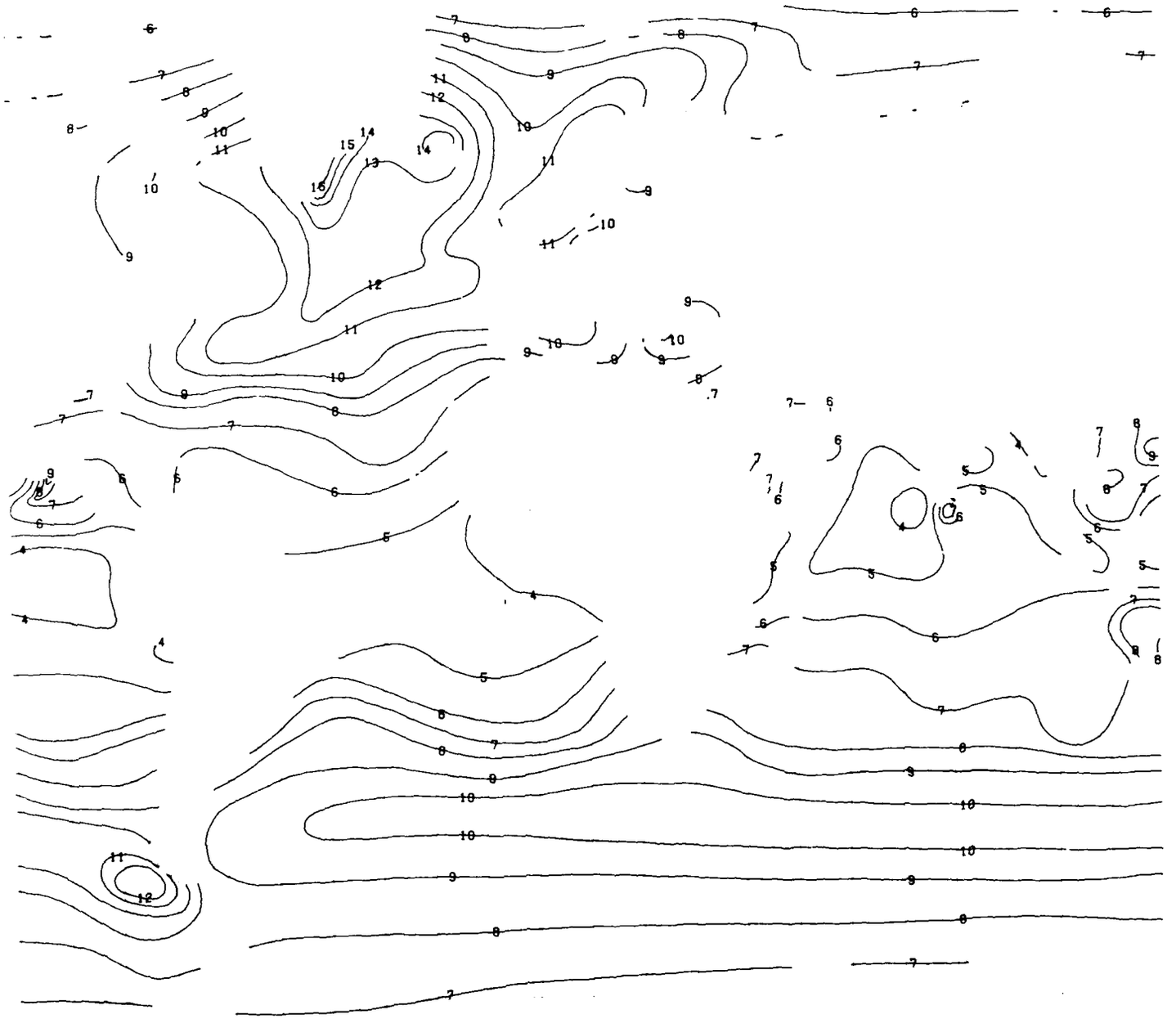

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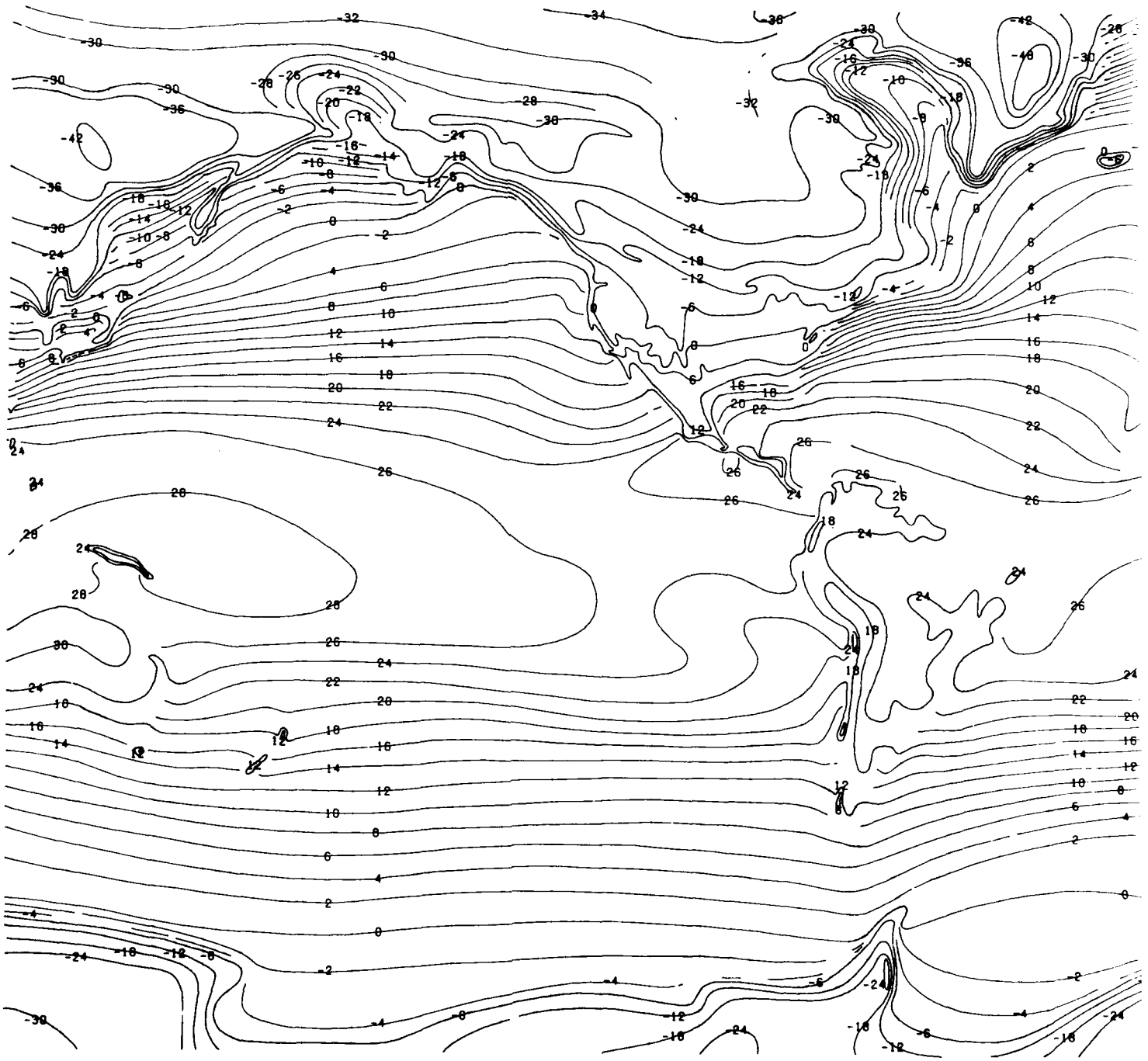

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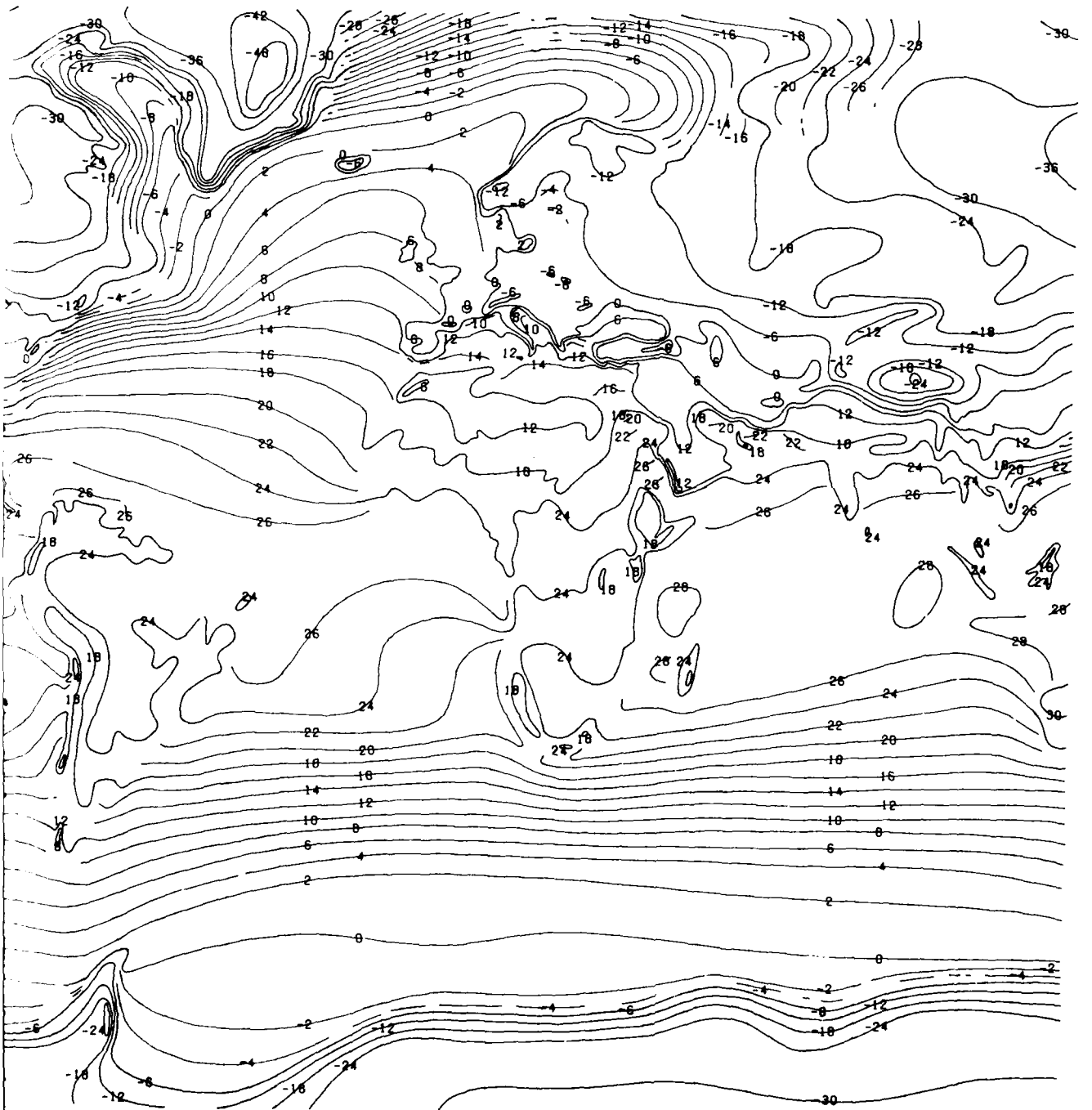

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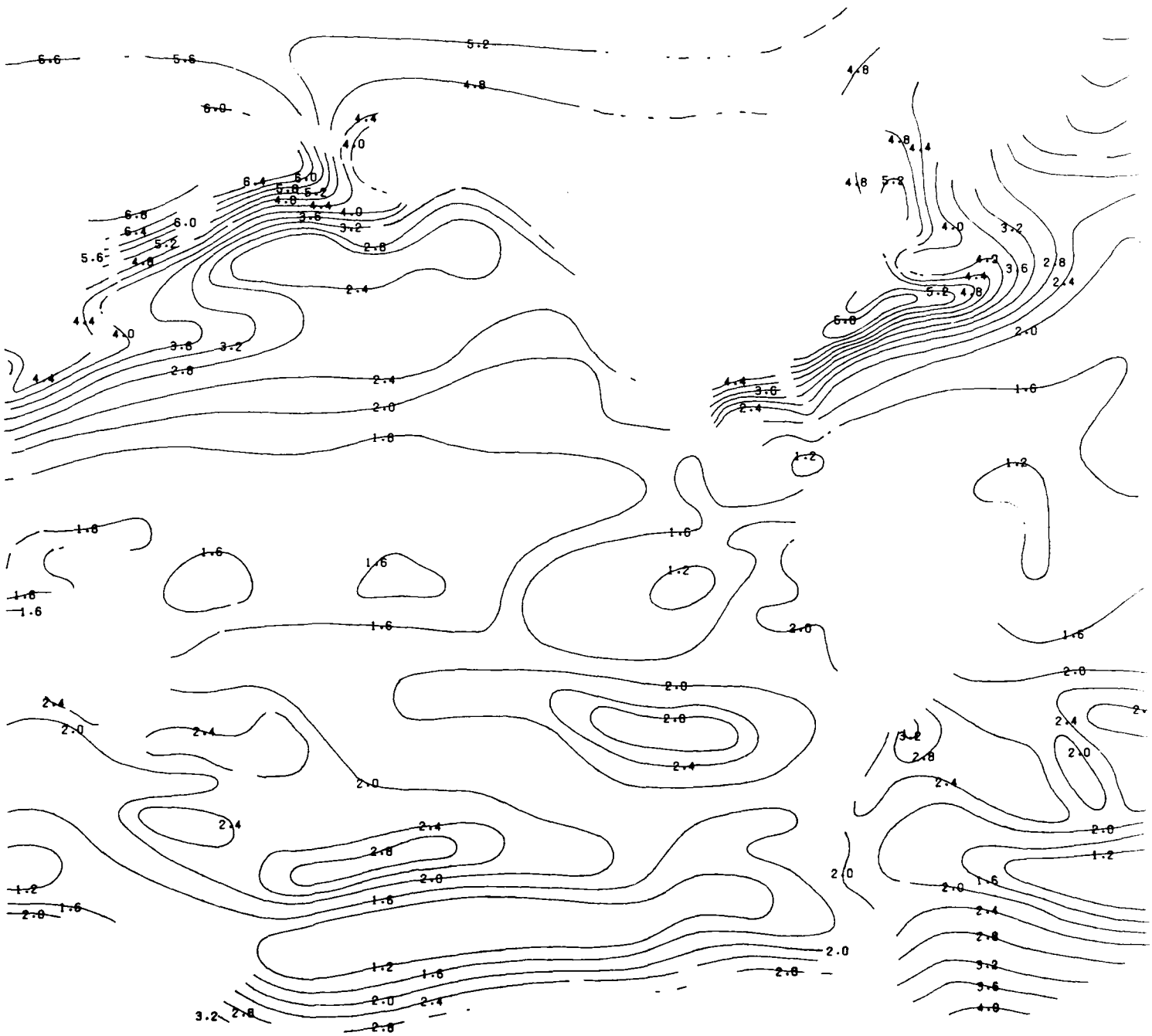

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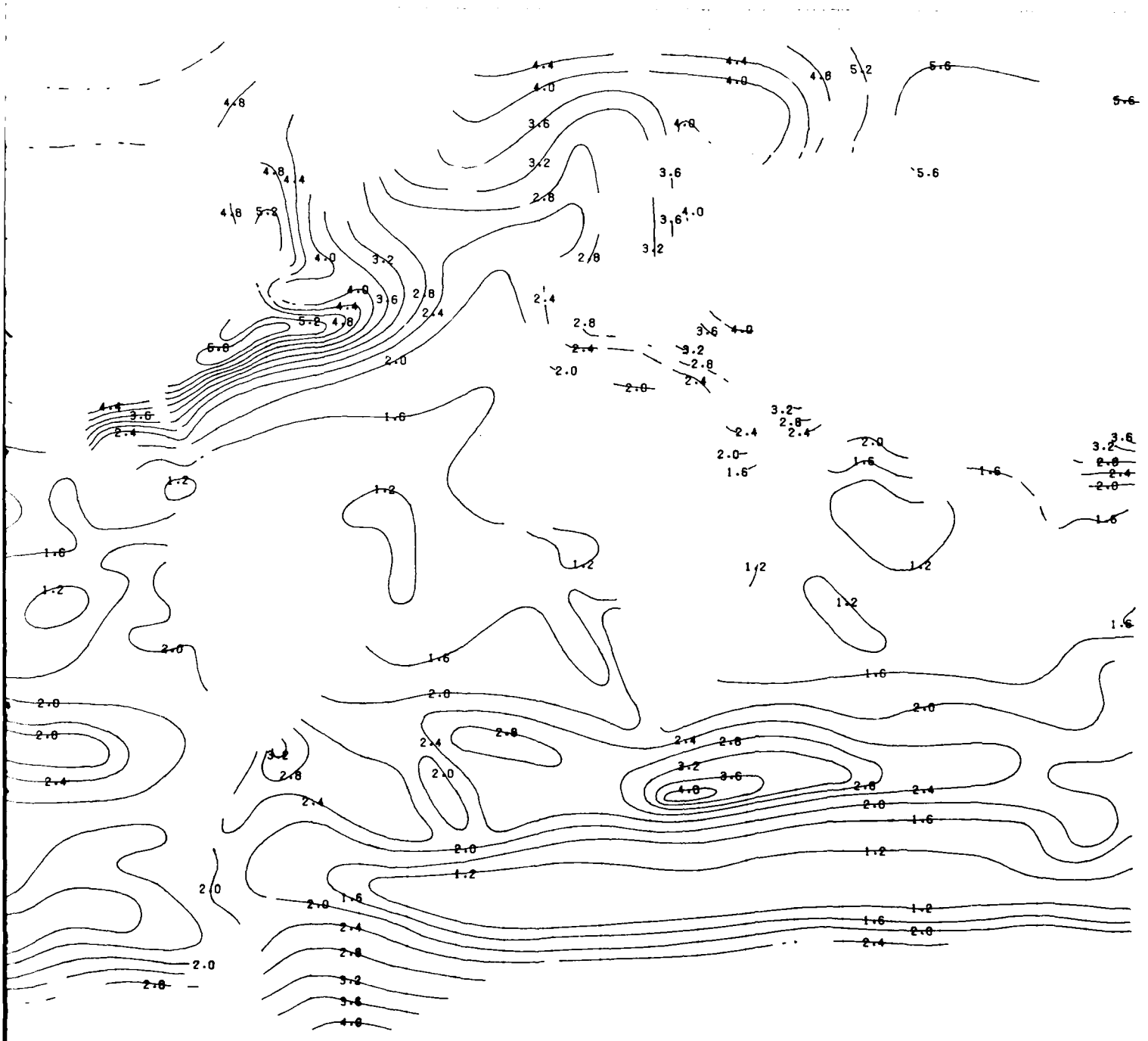

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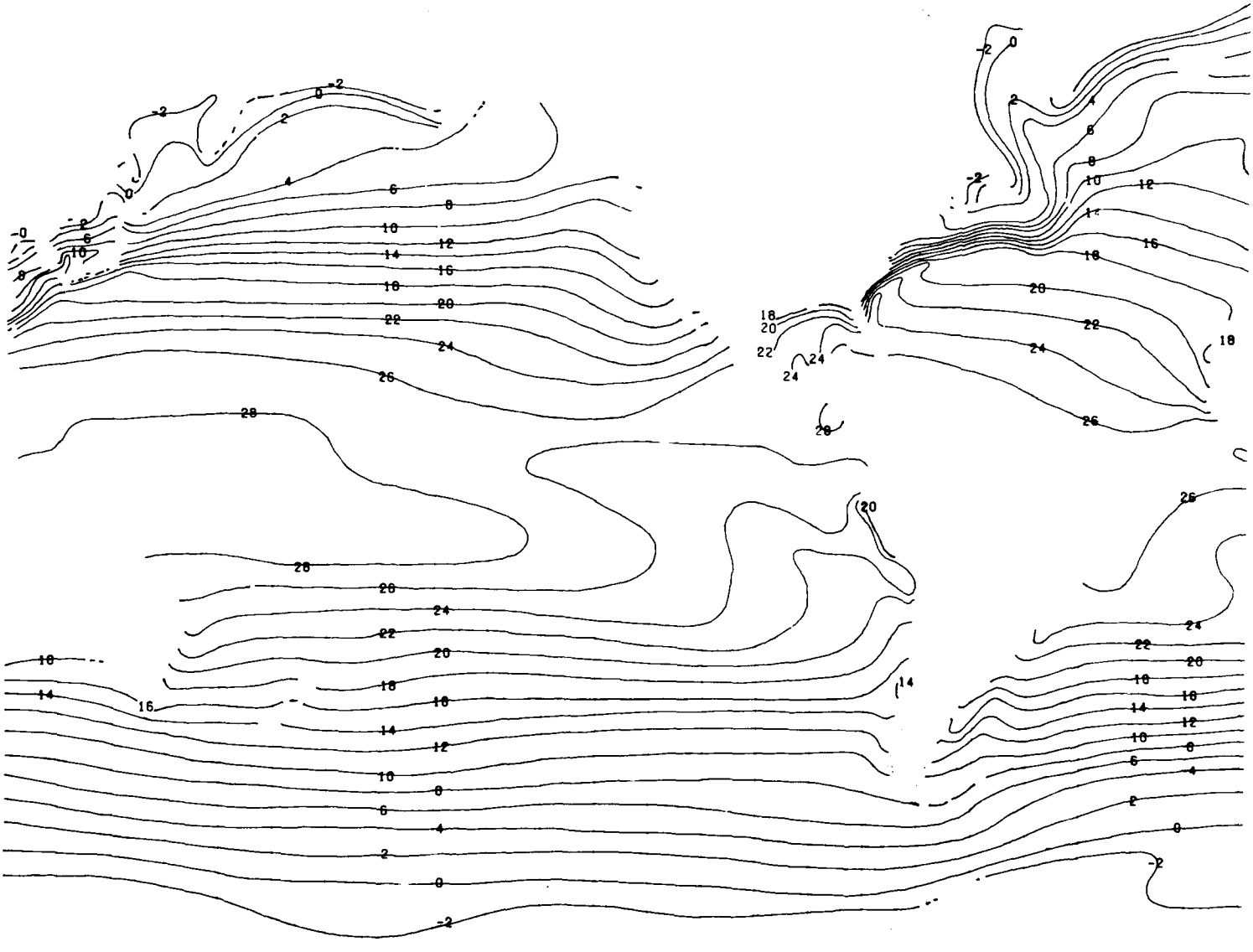

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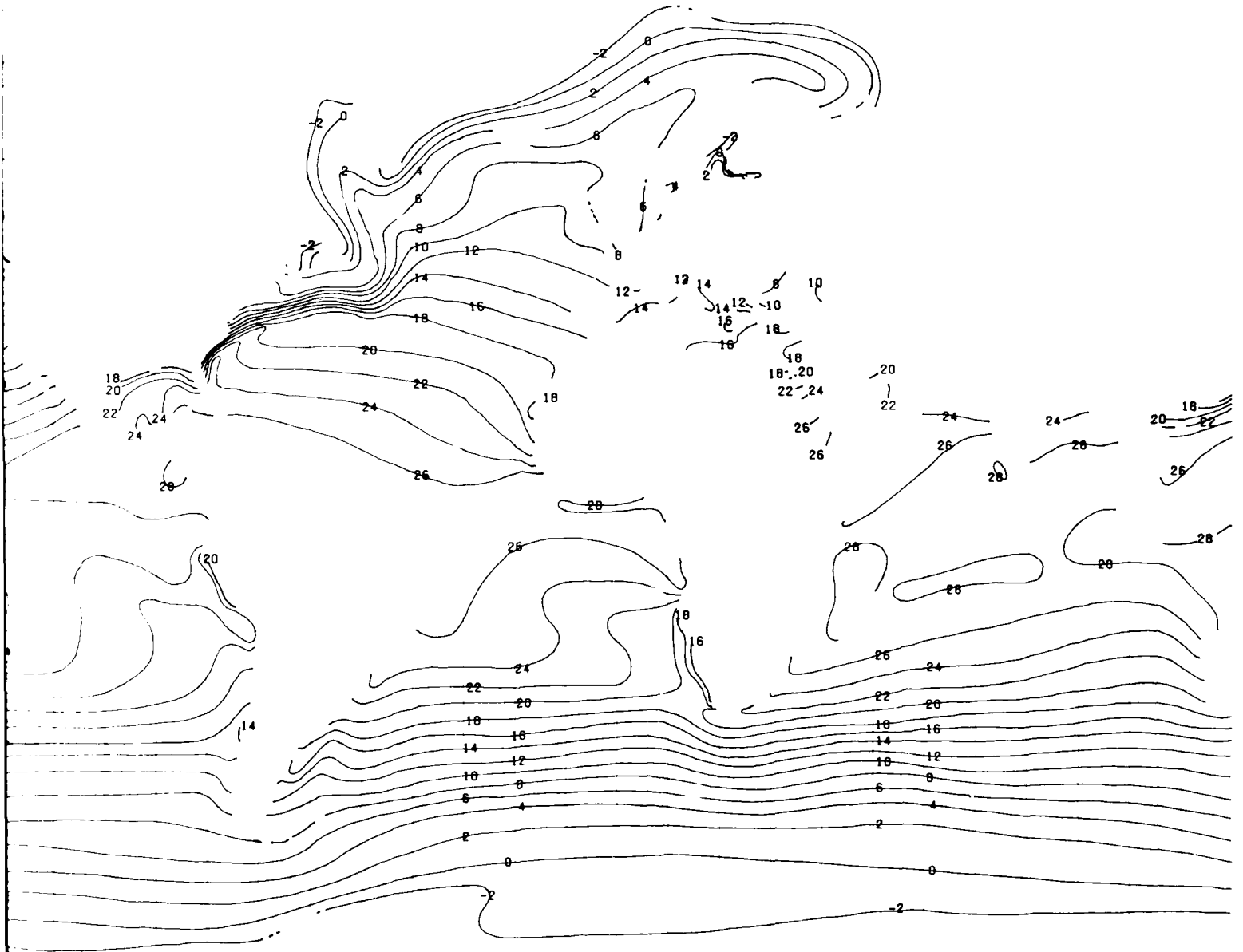

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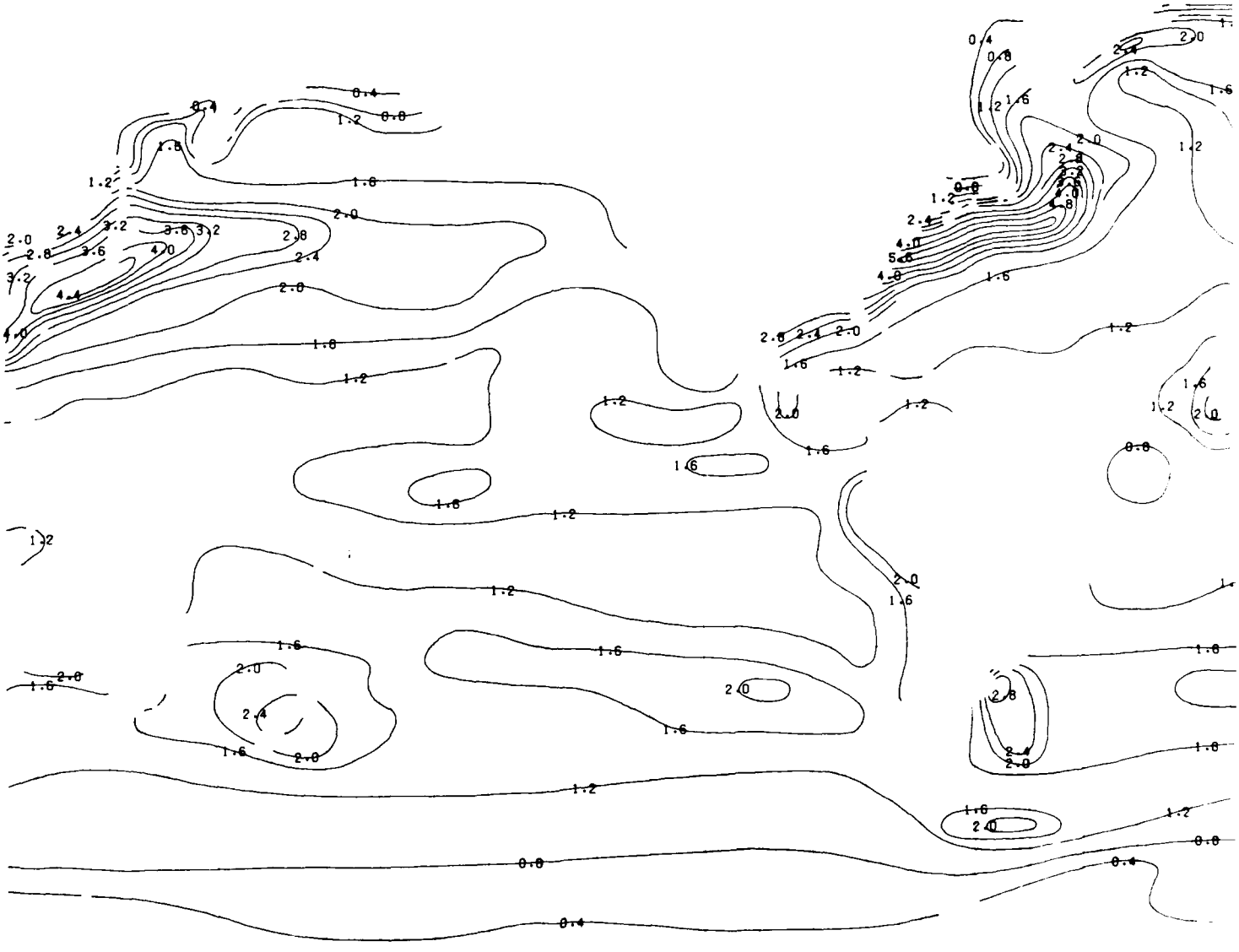

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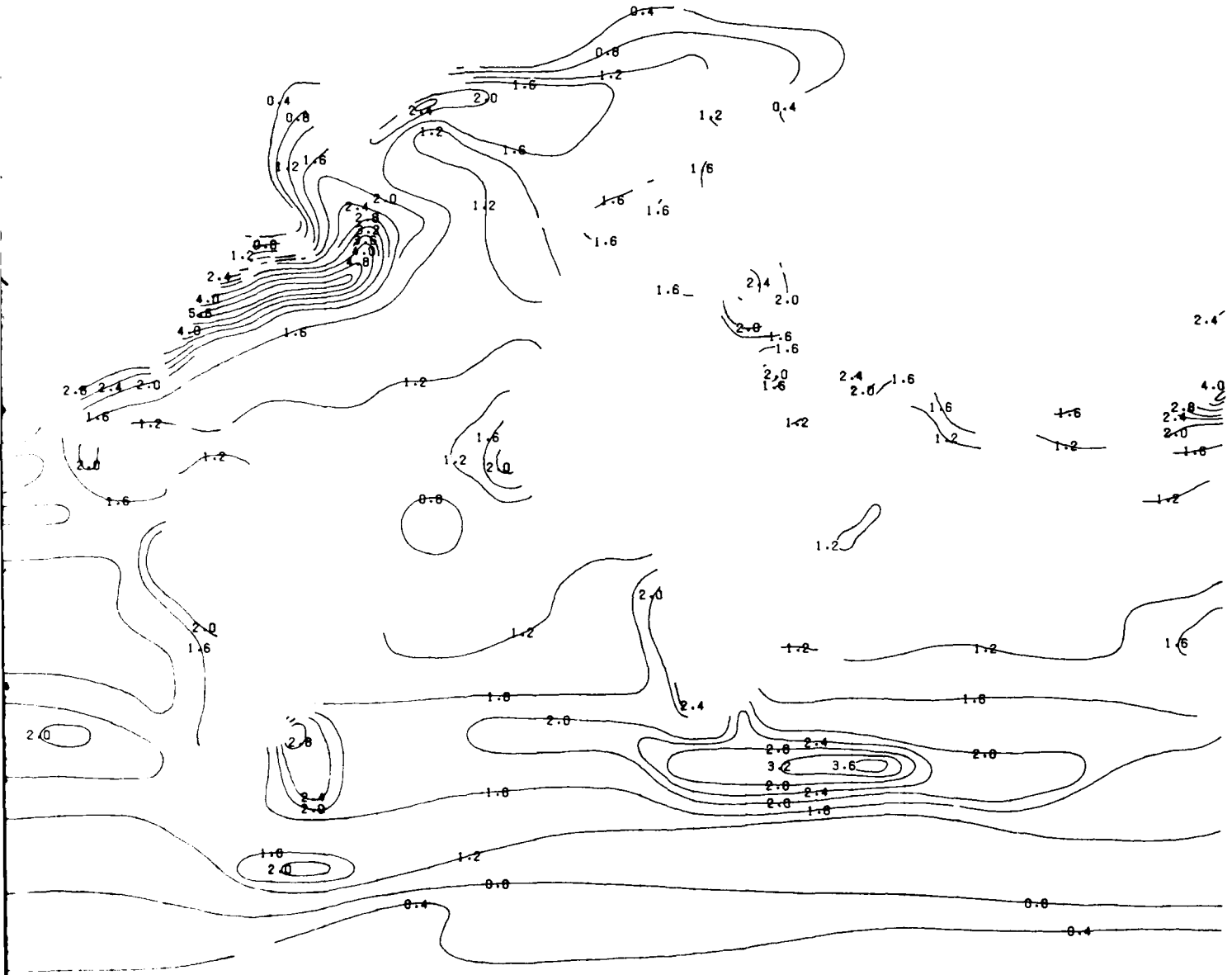

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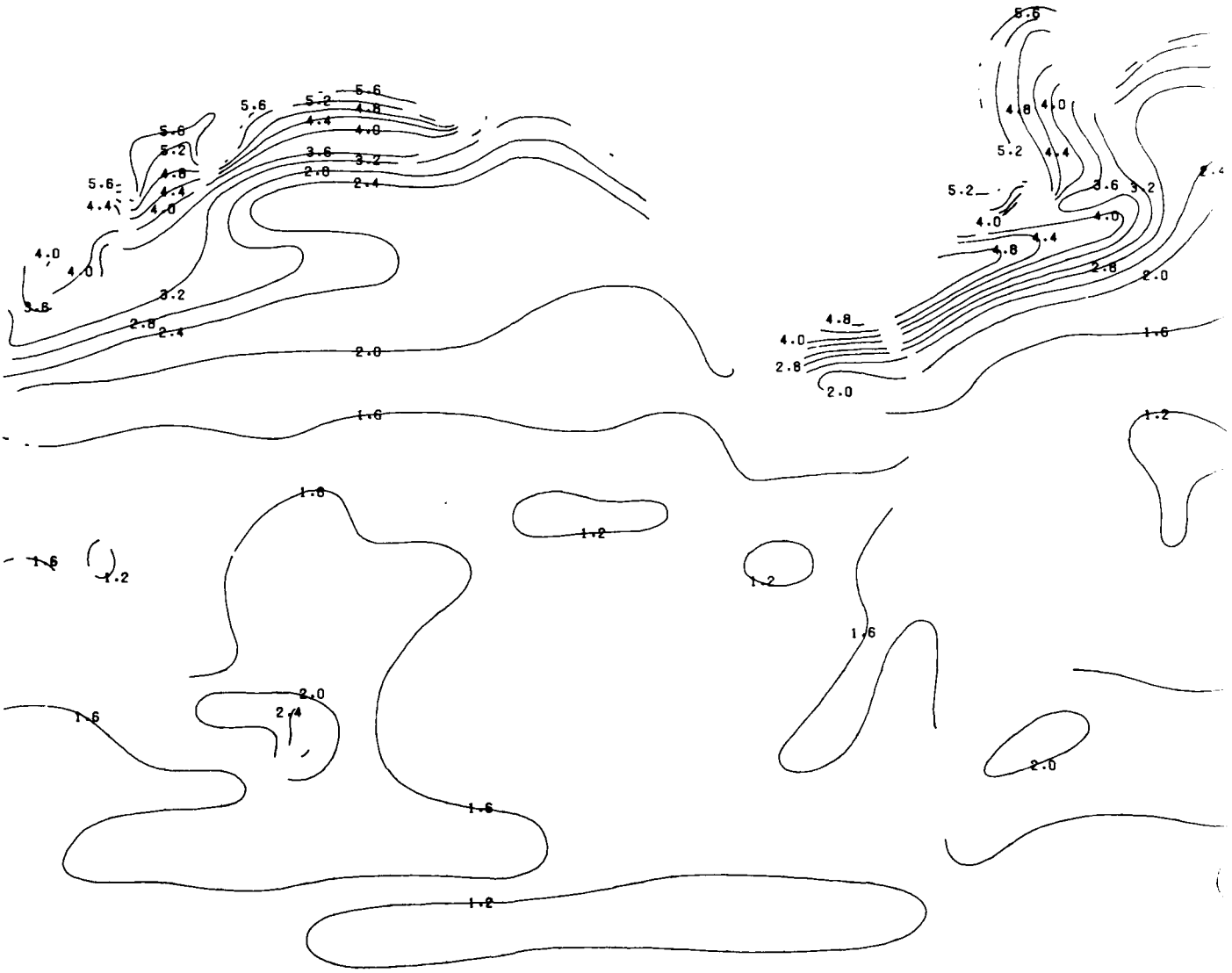
AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIONS



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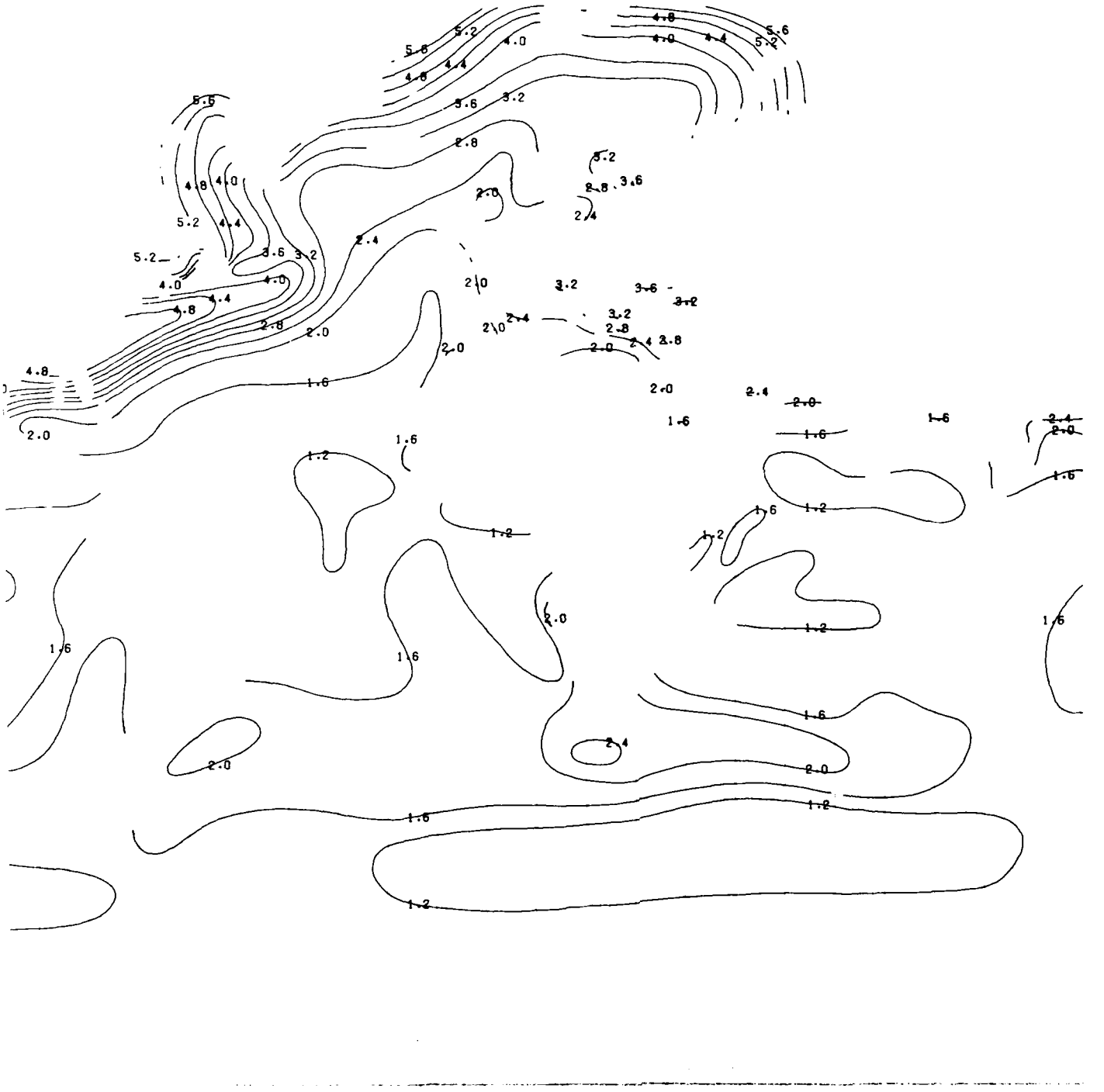

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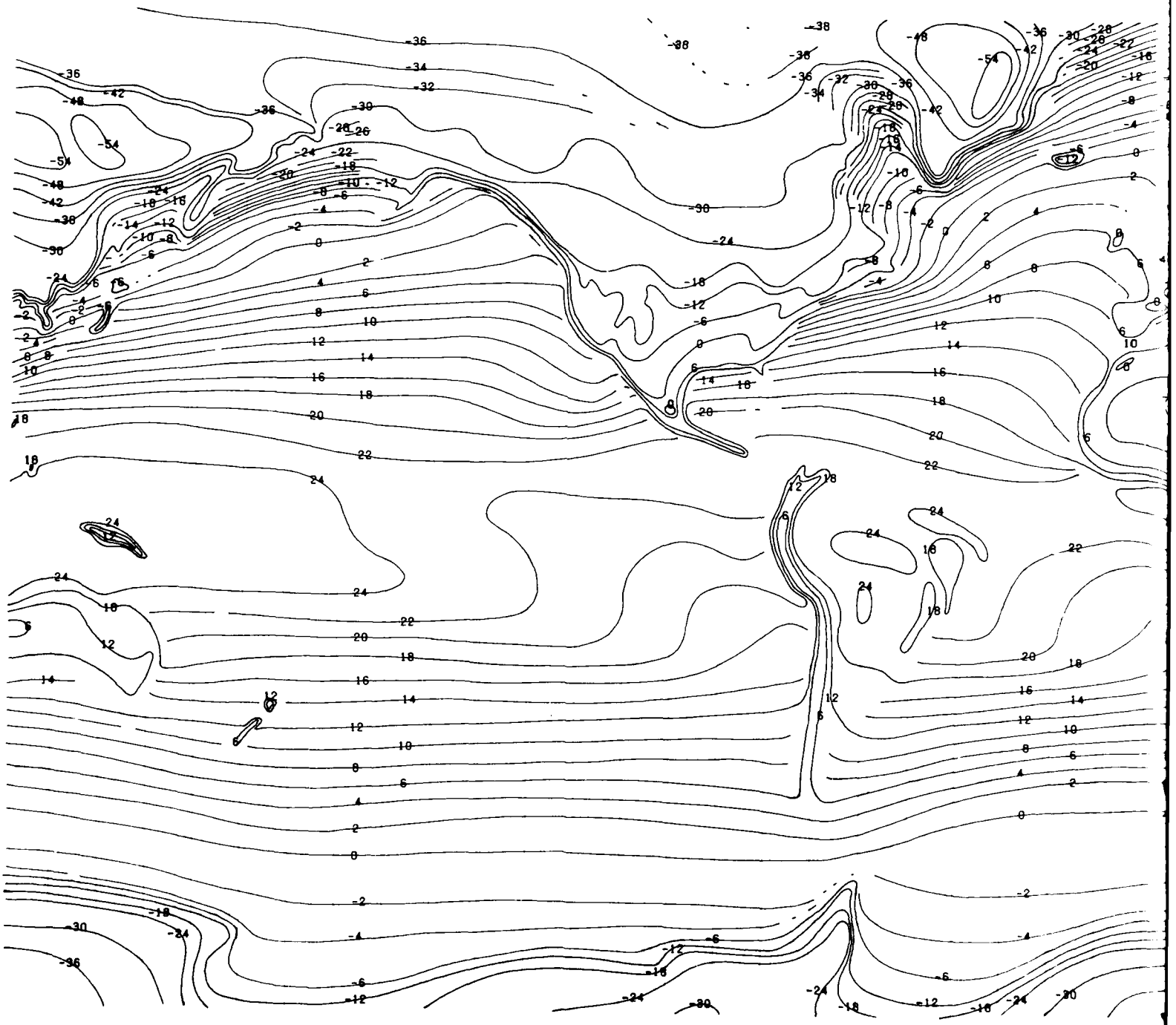

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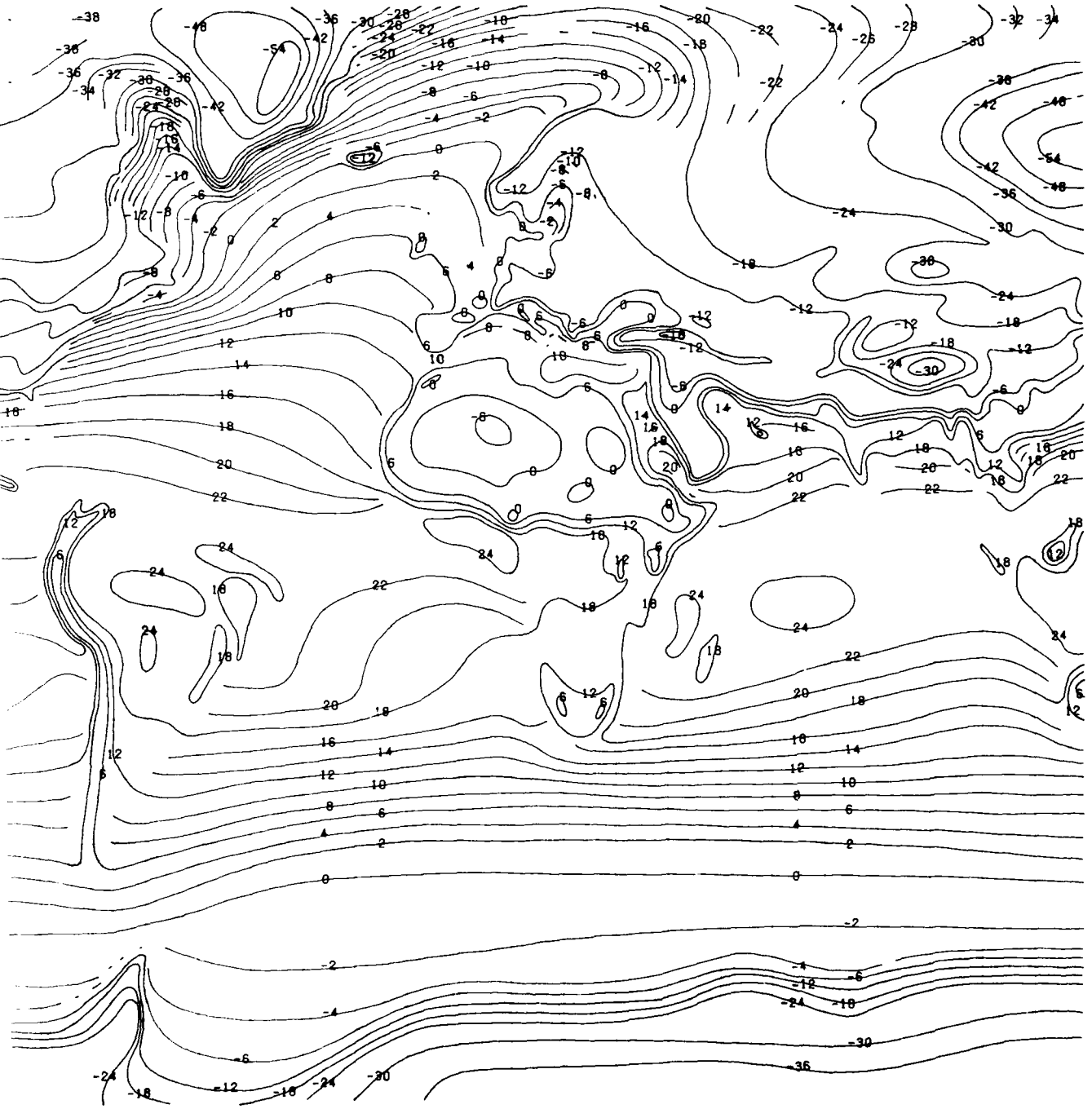

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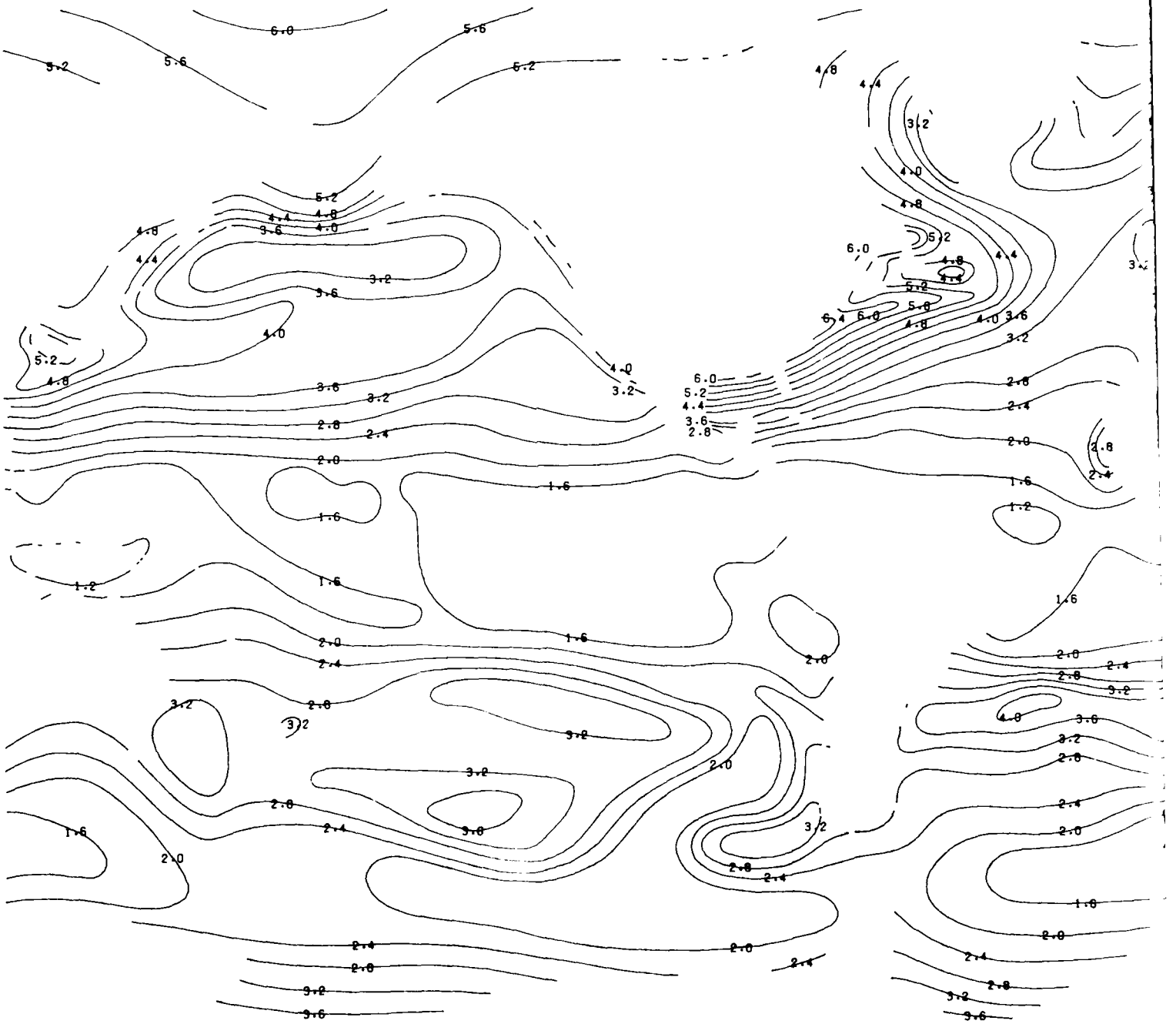

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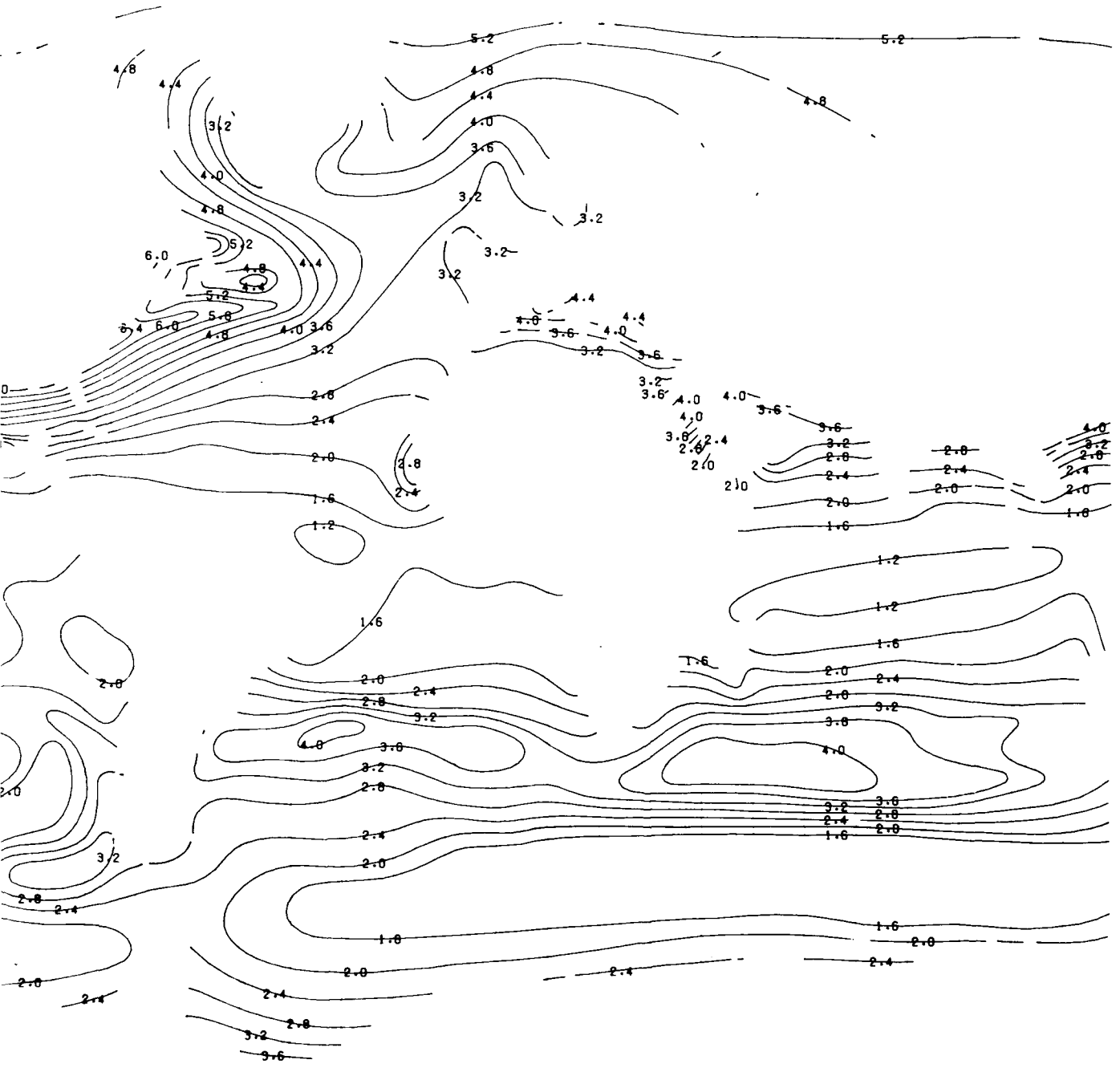

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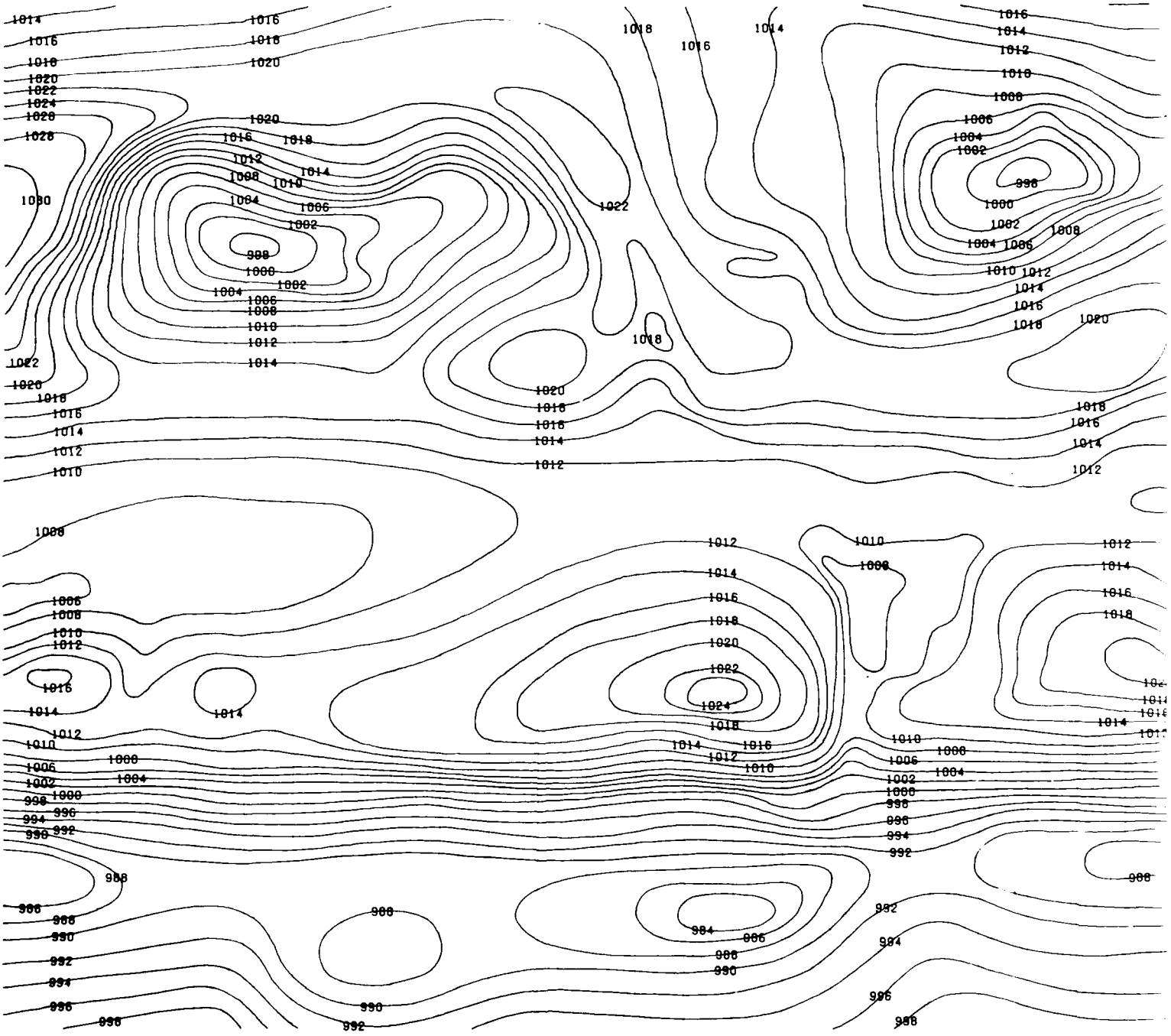

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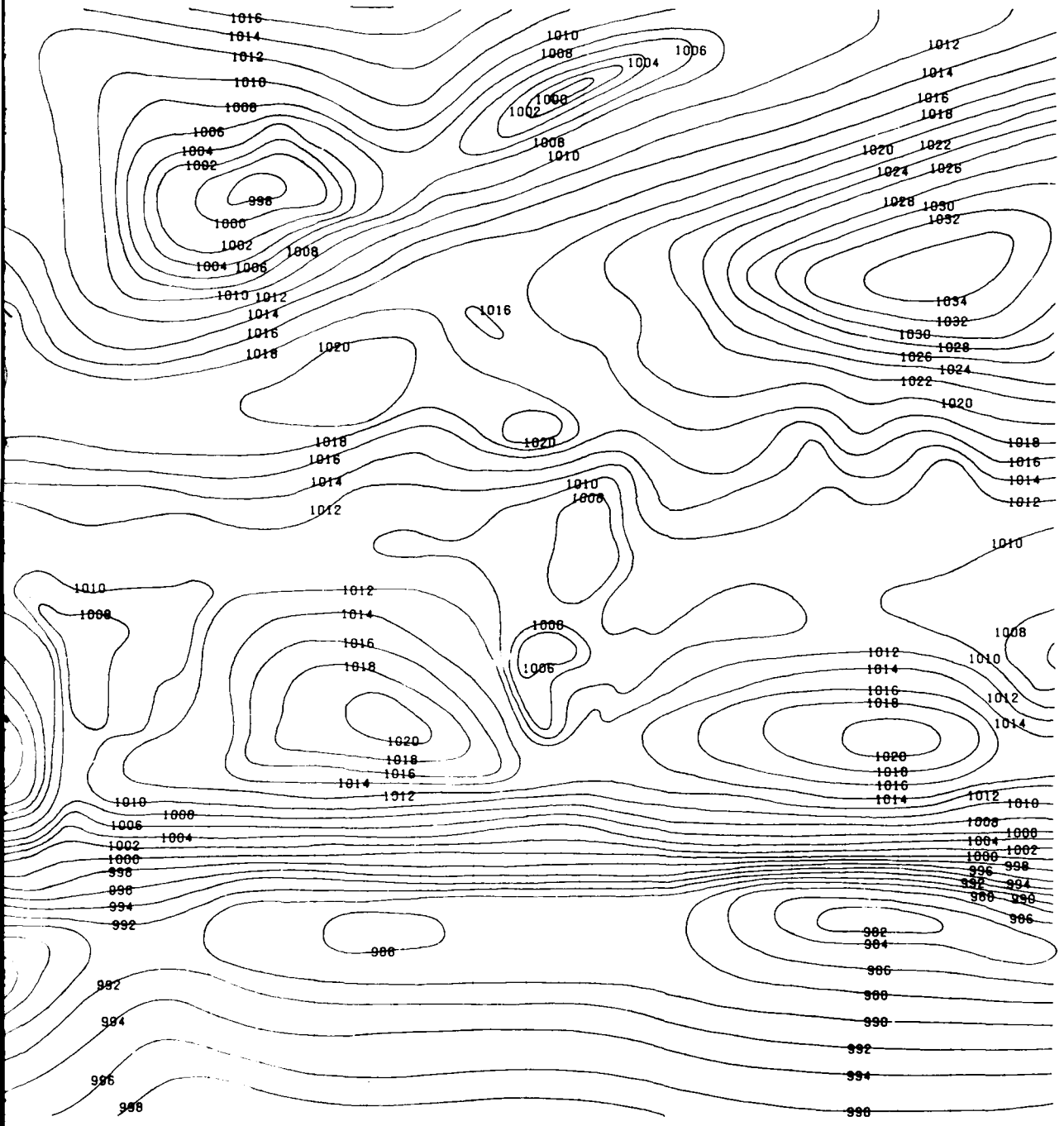

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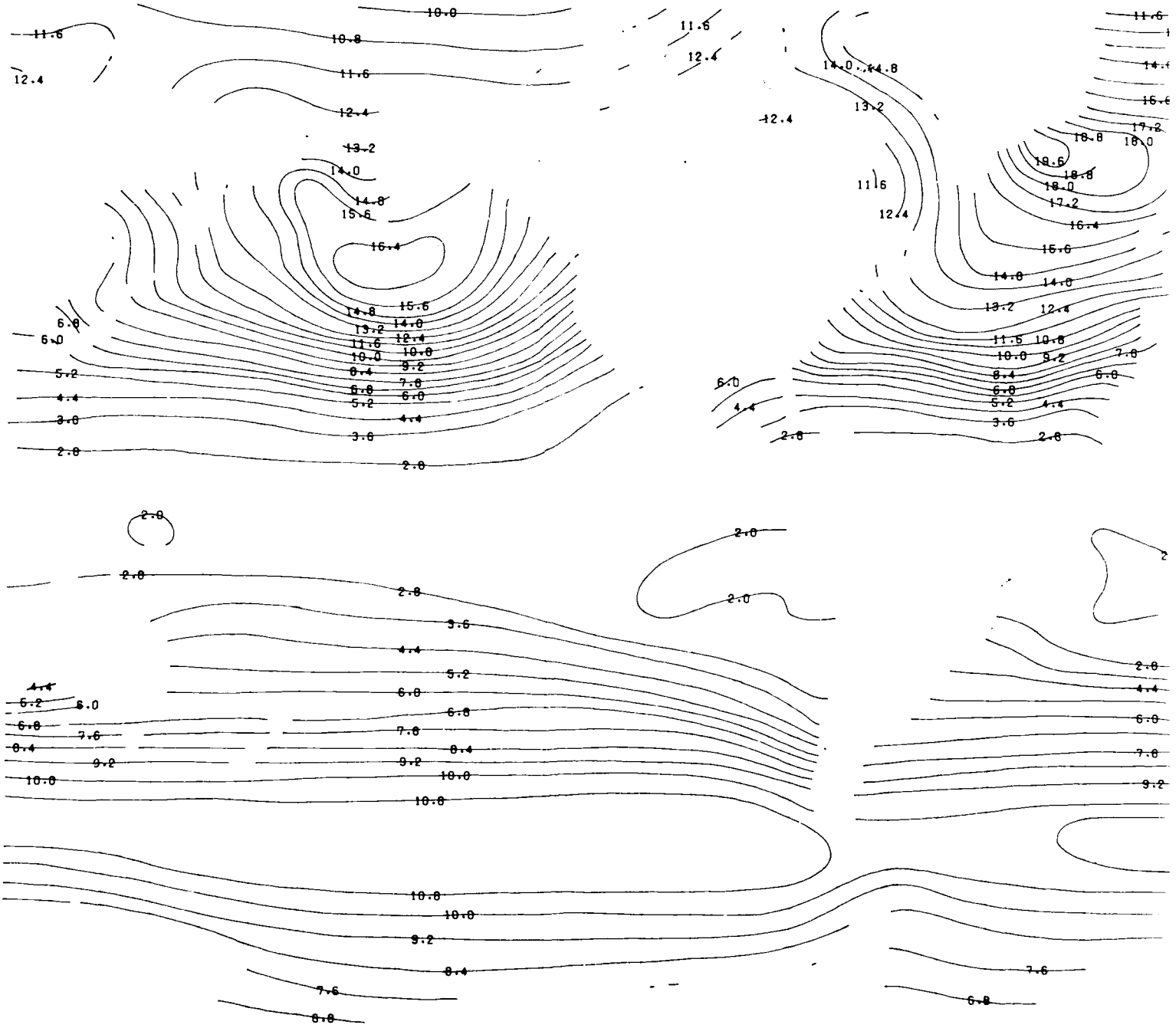

RD DEVIATIONS

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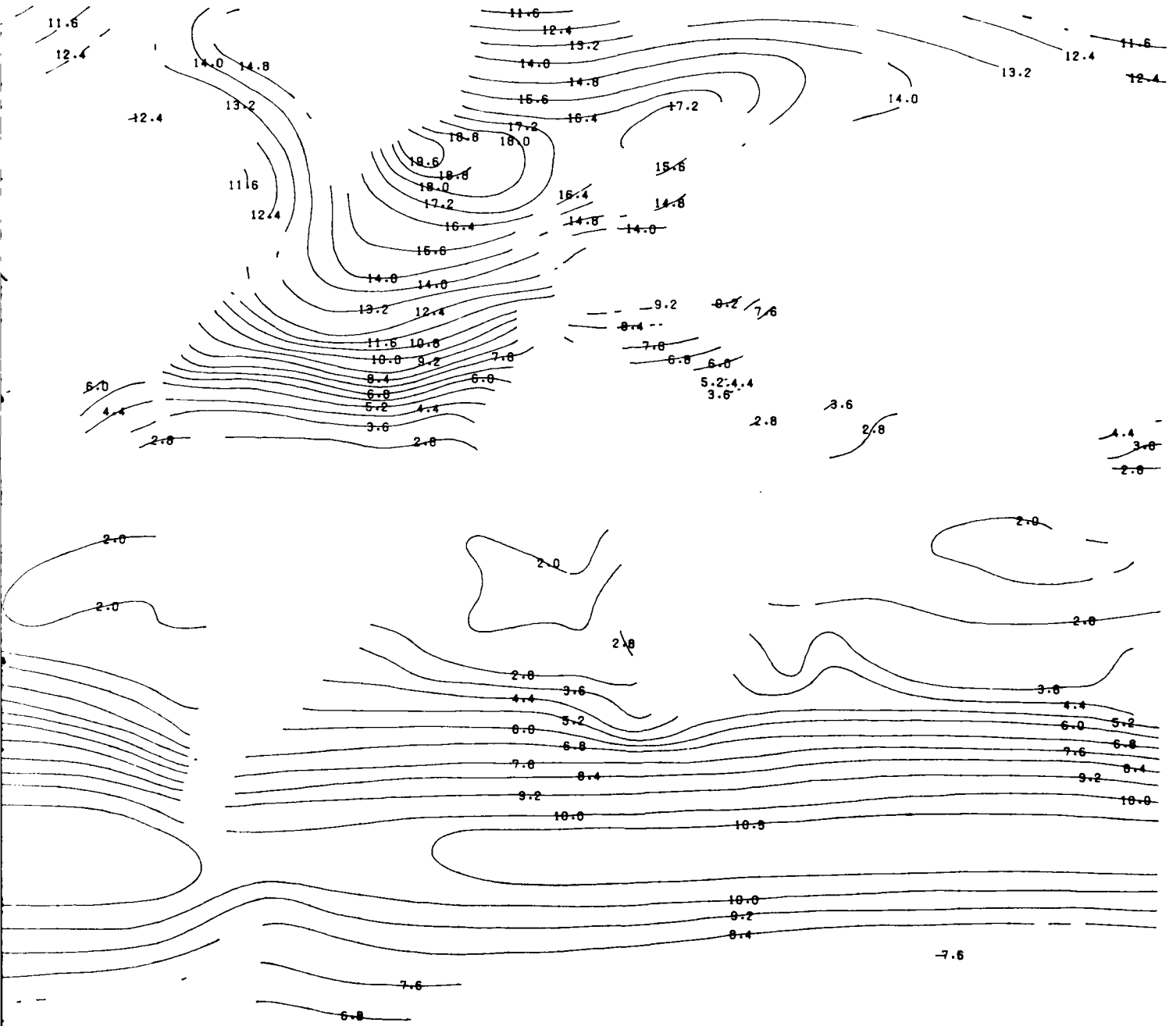

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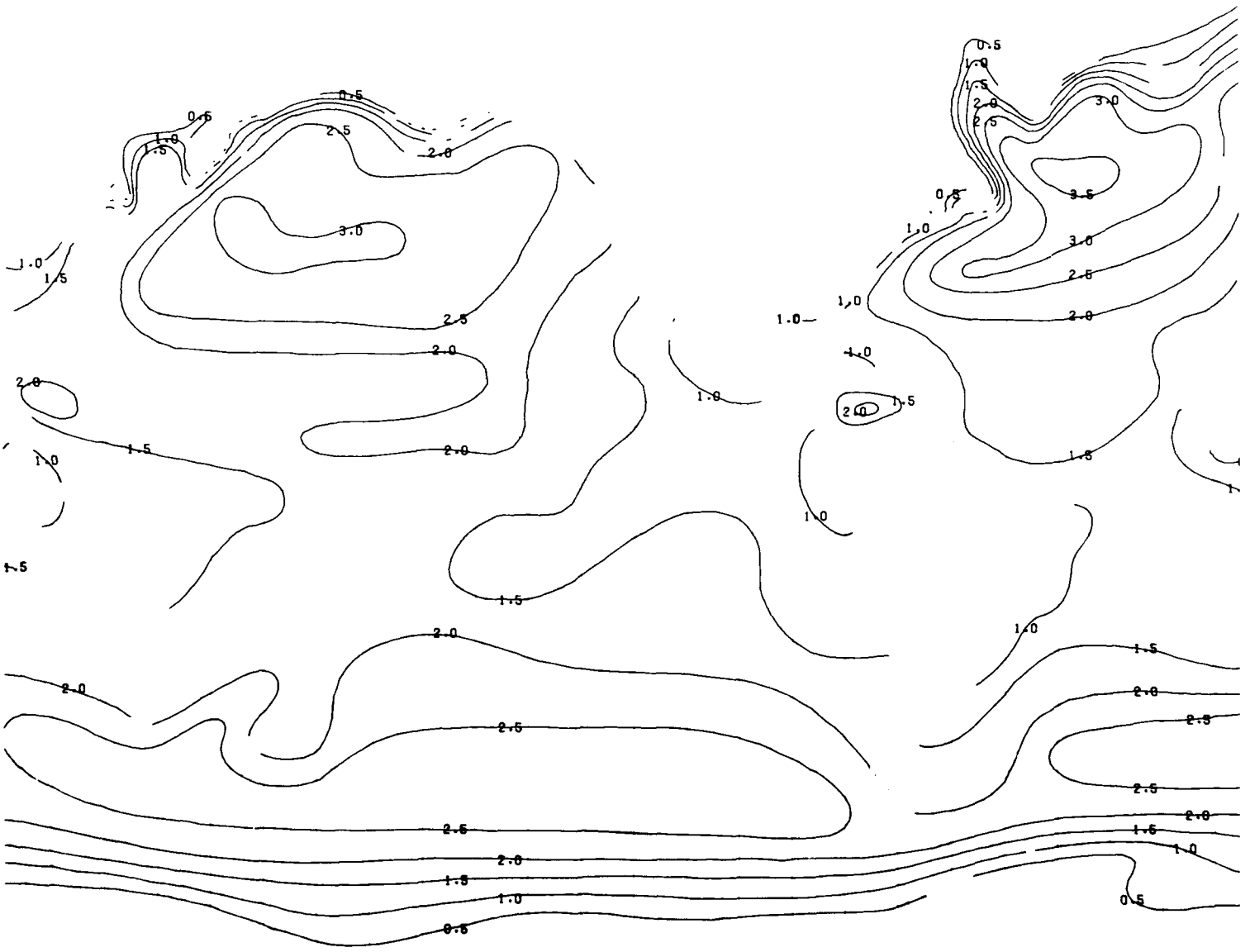

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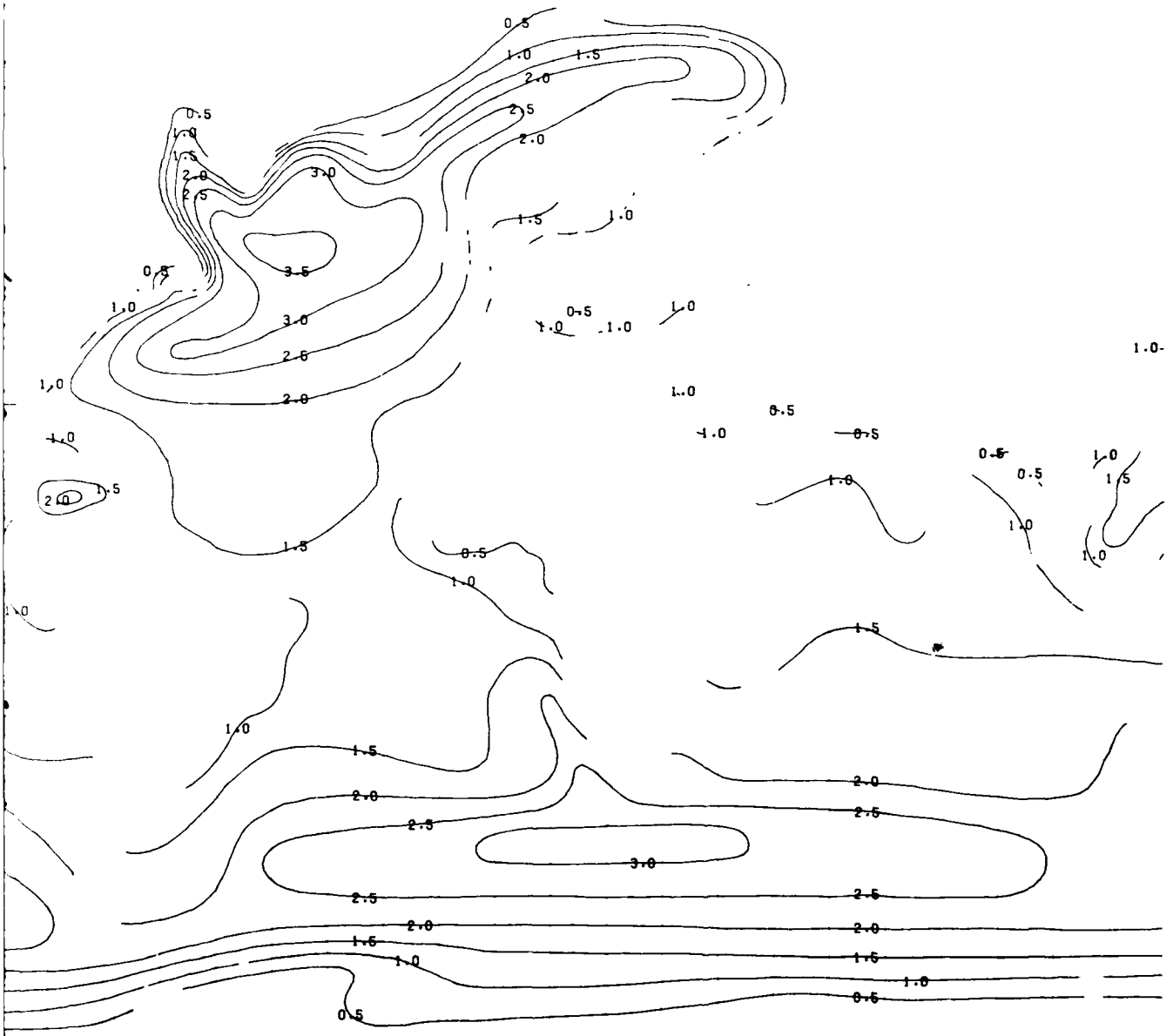

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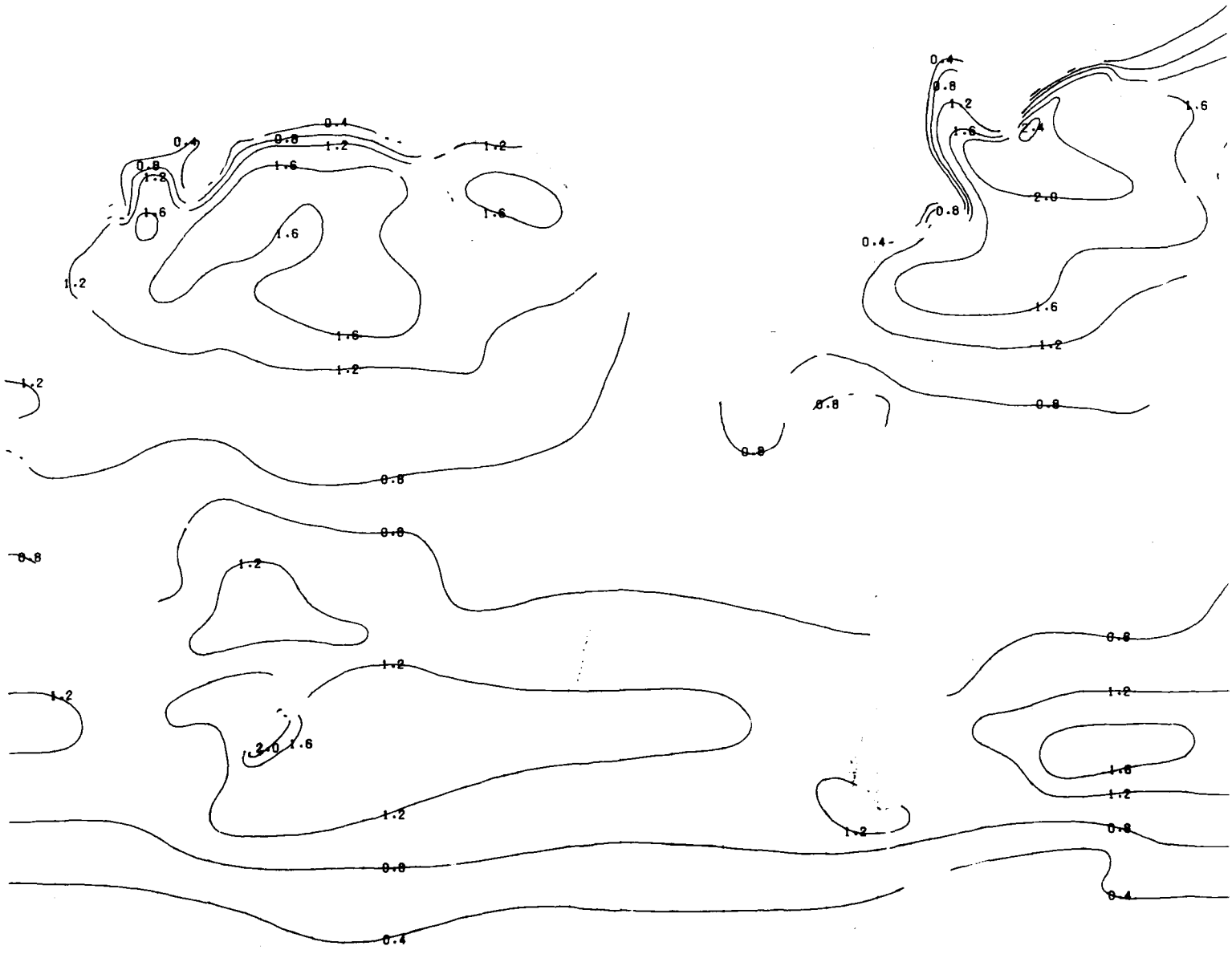

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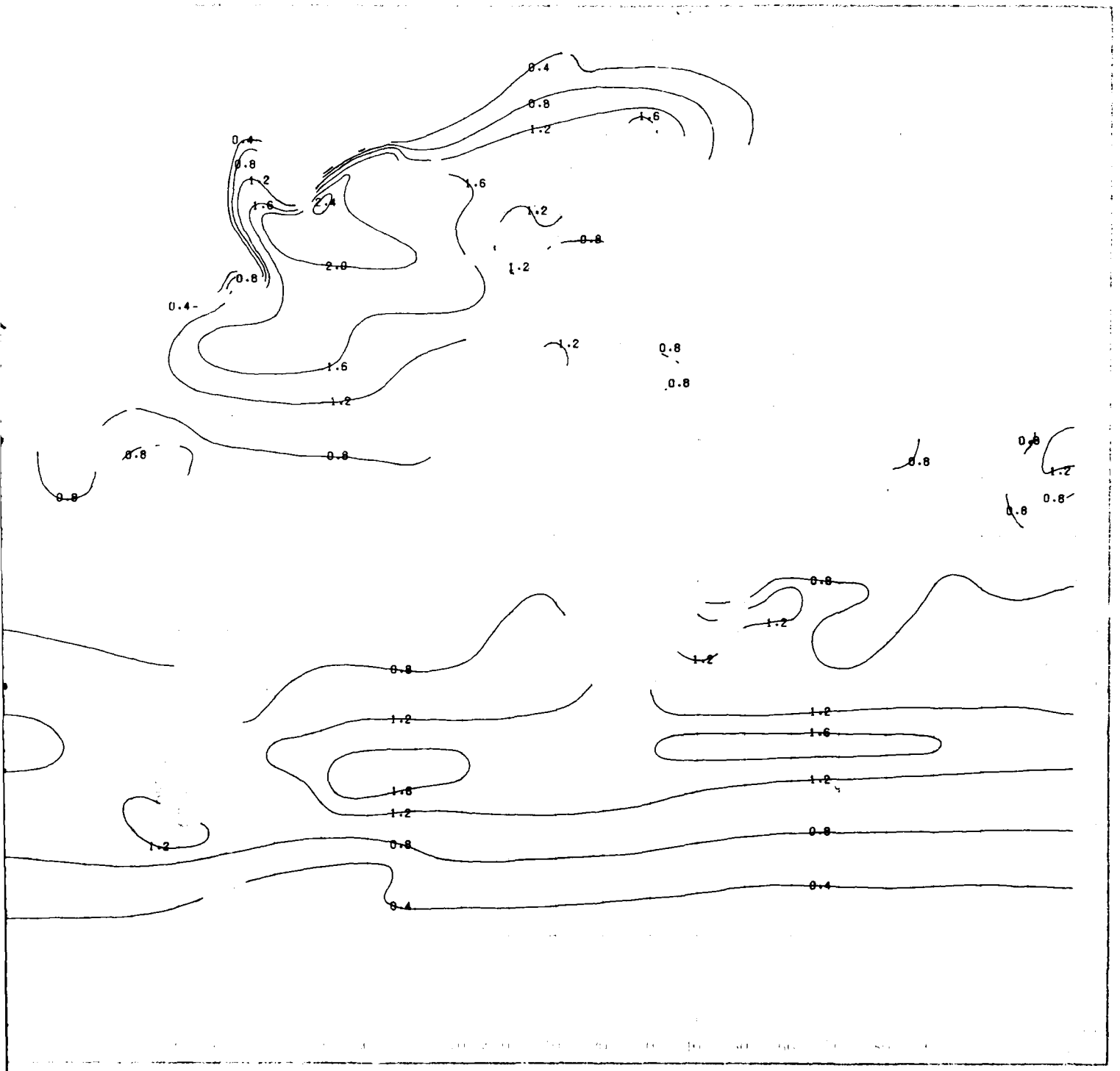

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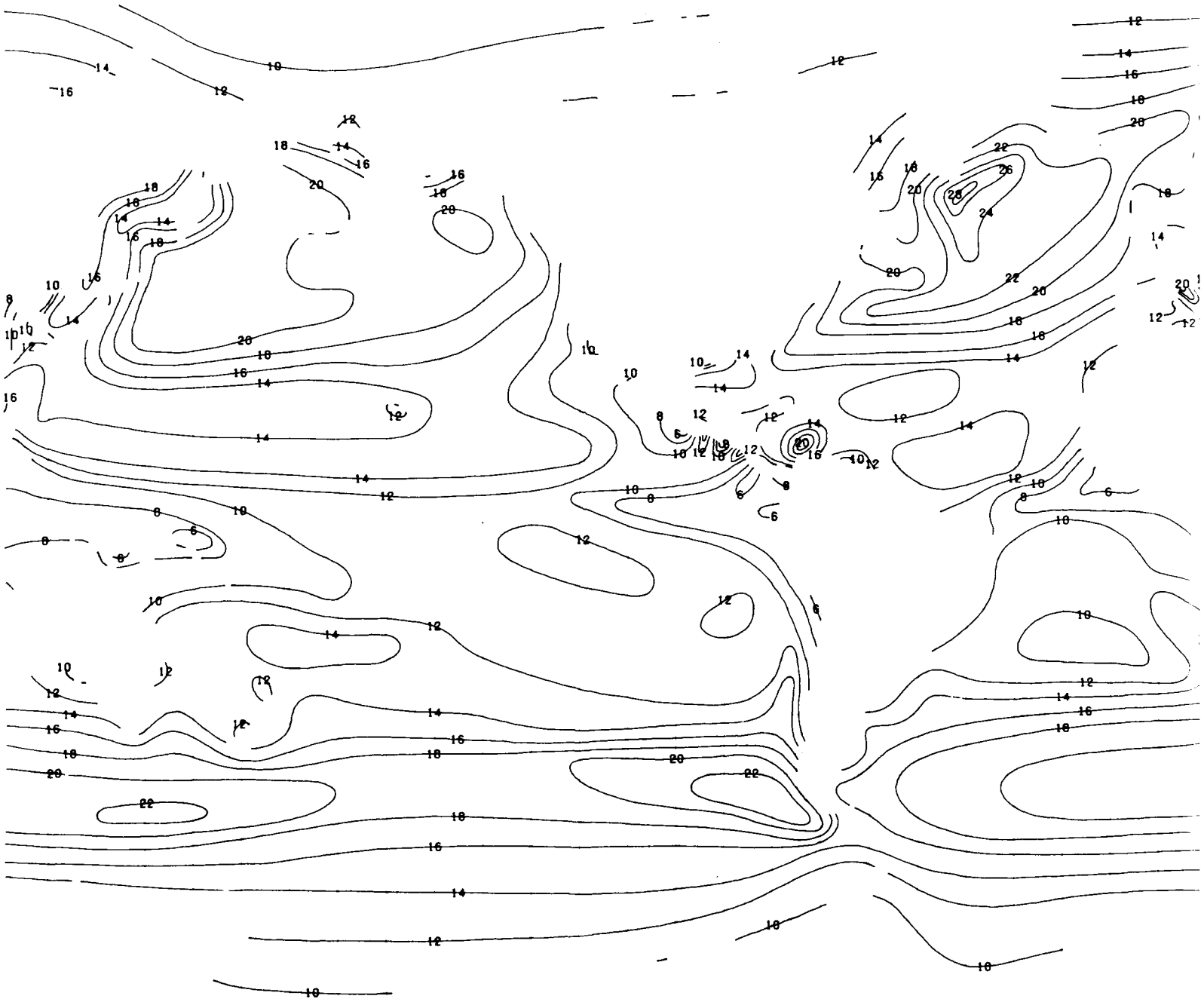

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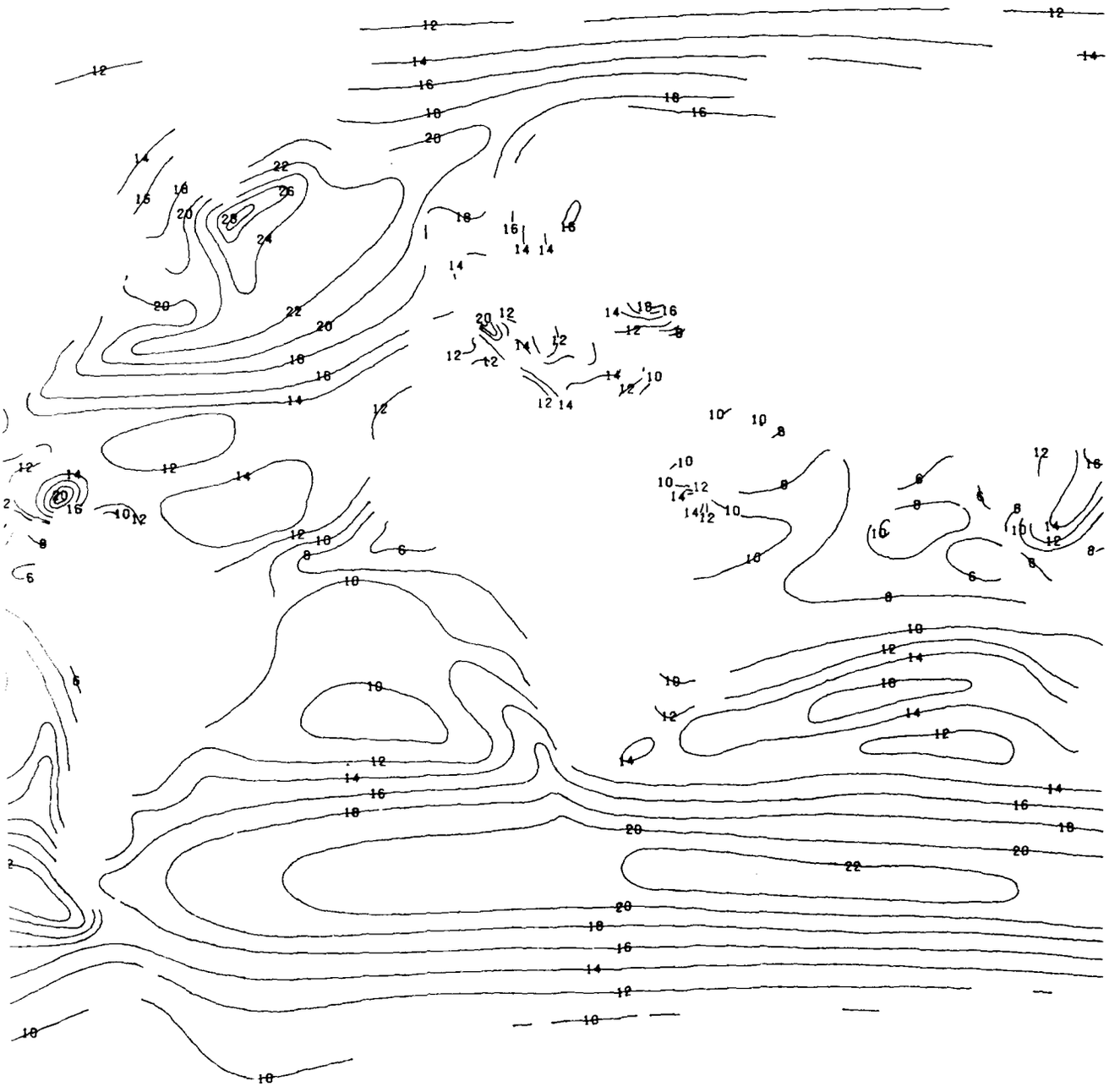

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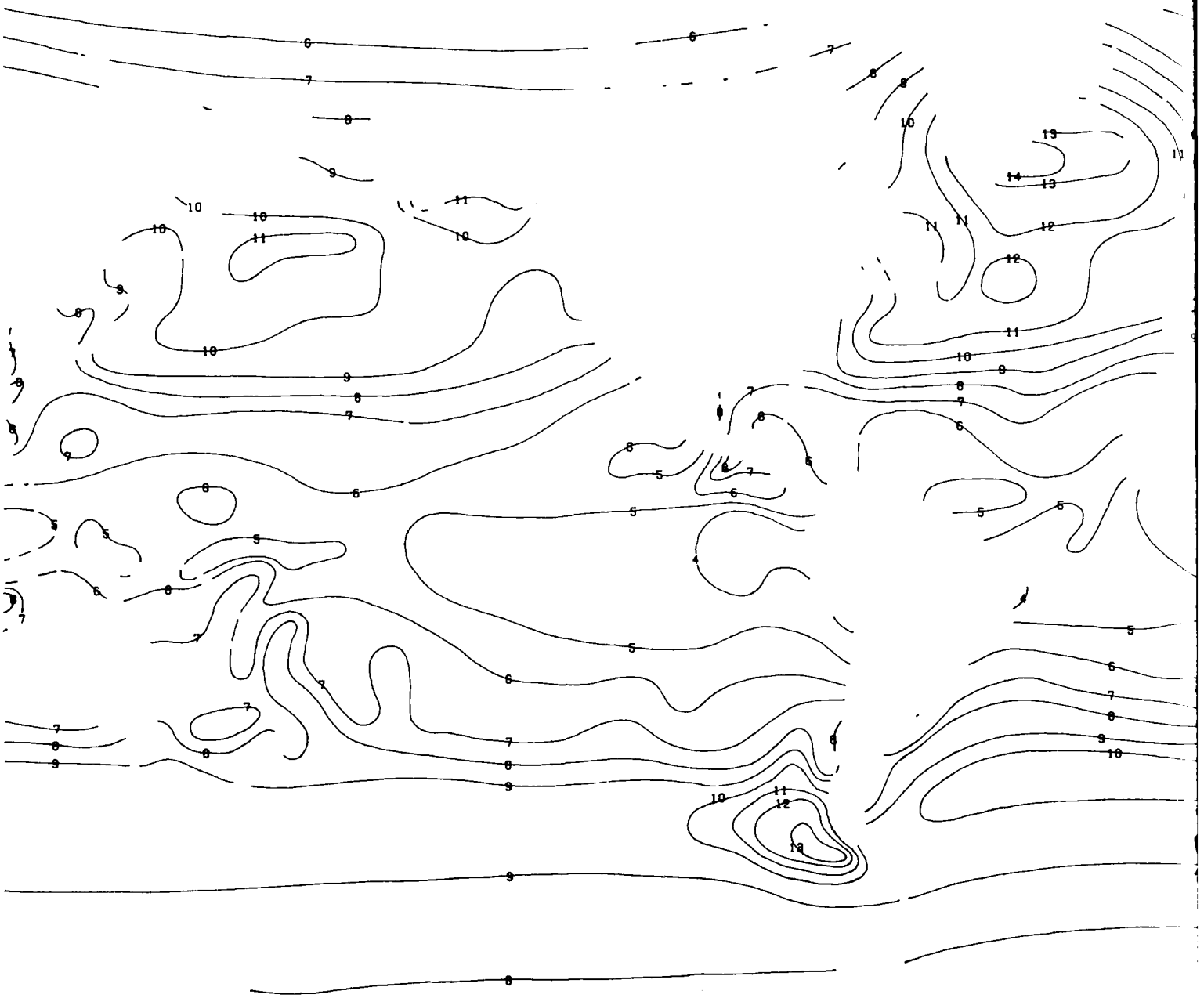

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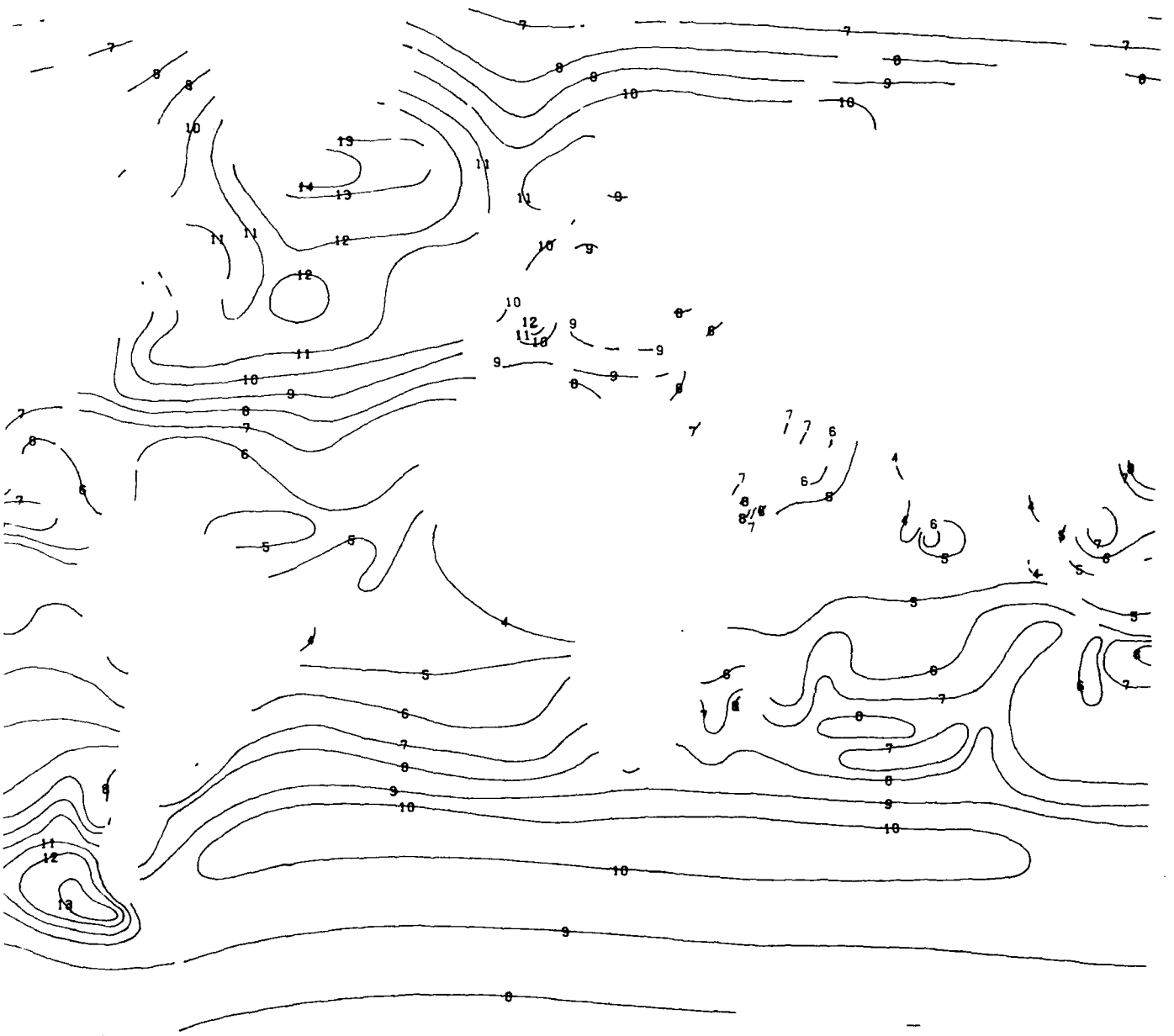

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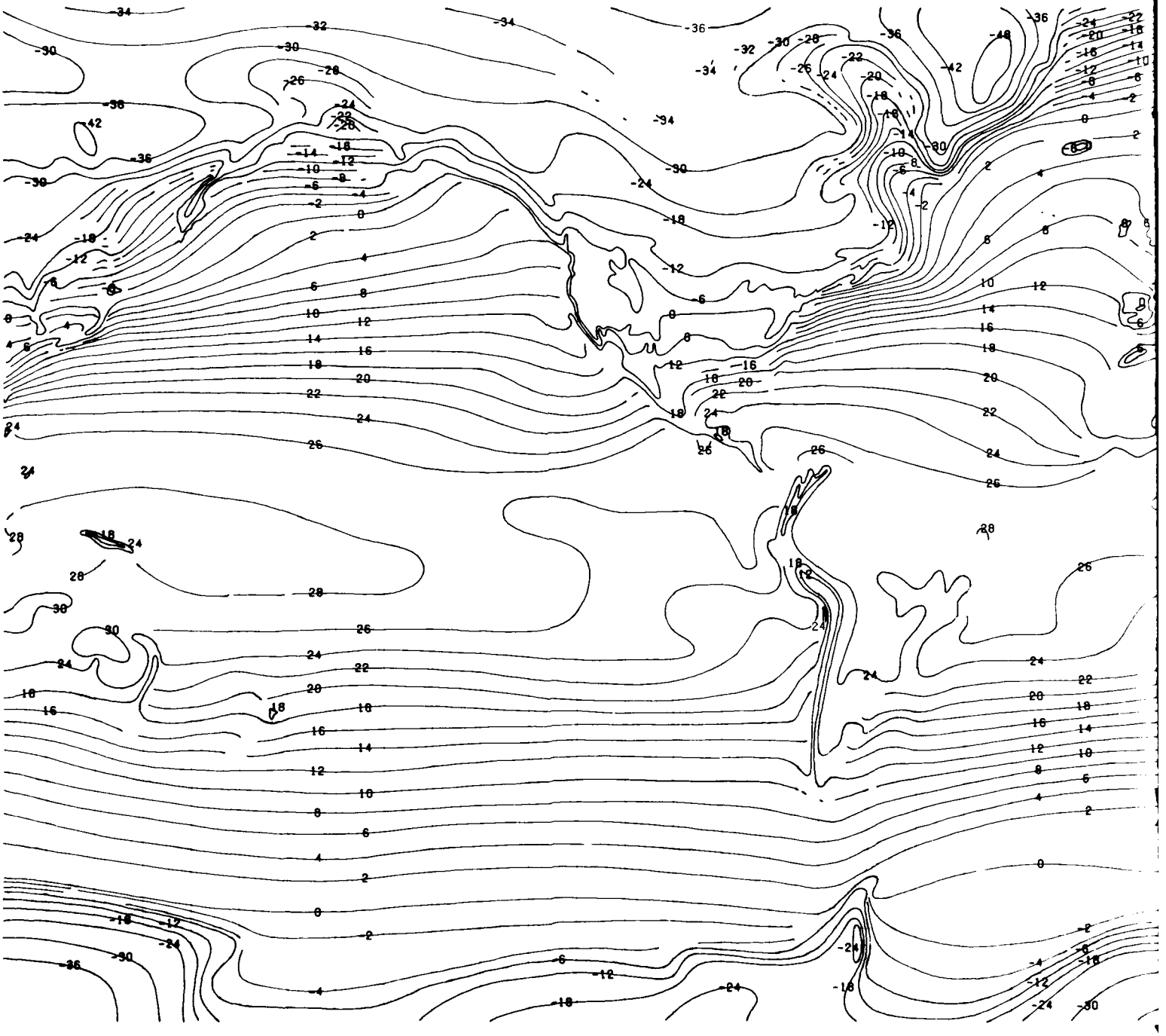

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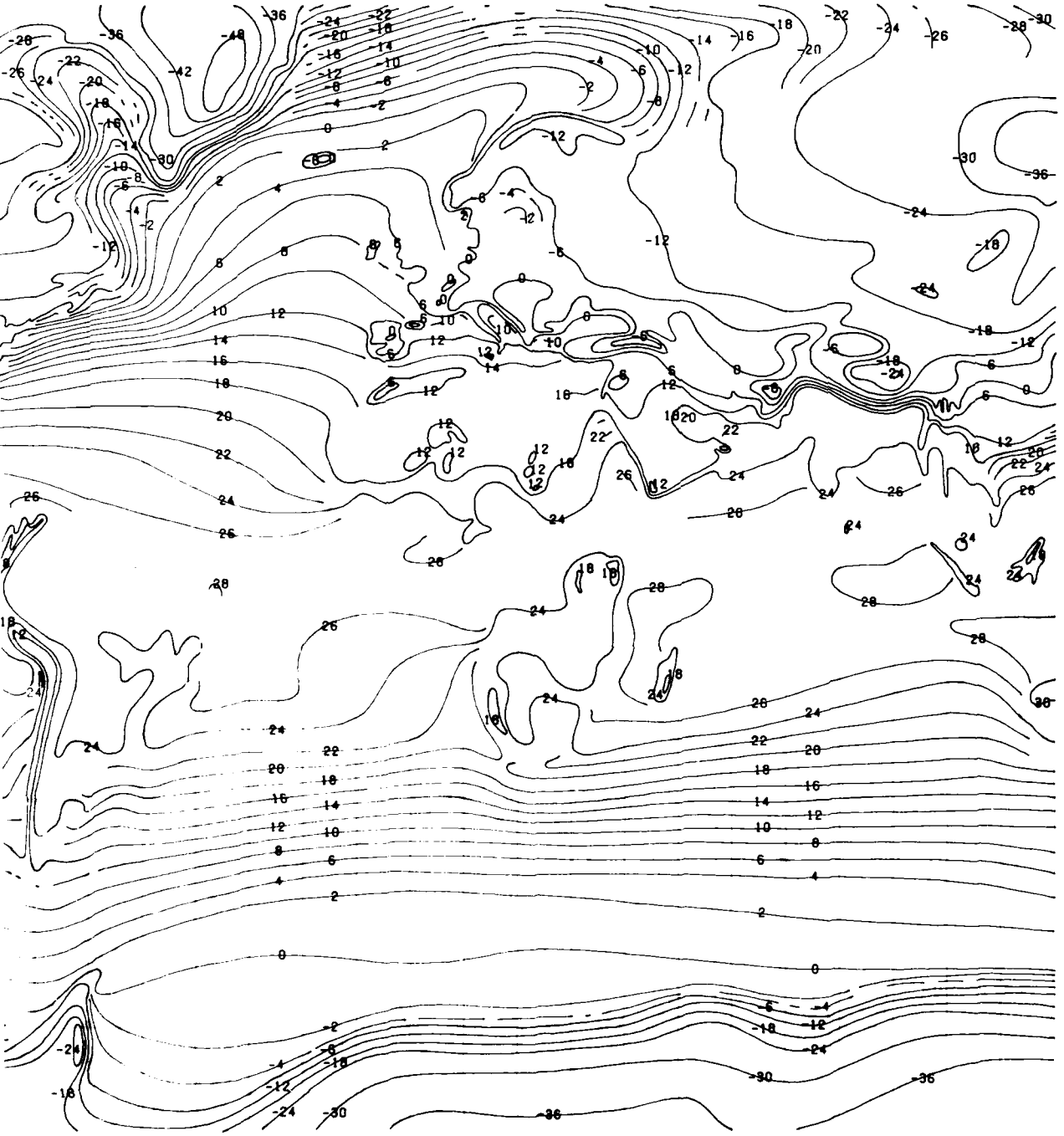

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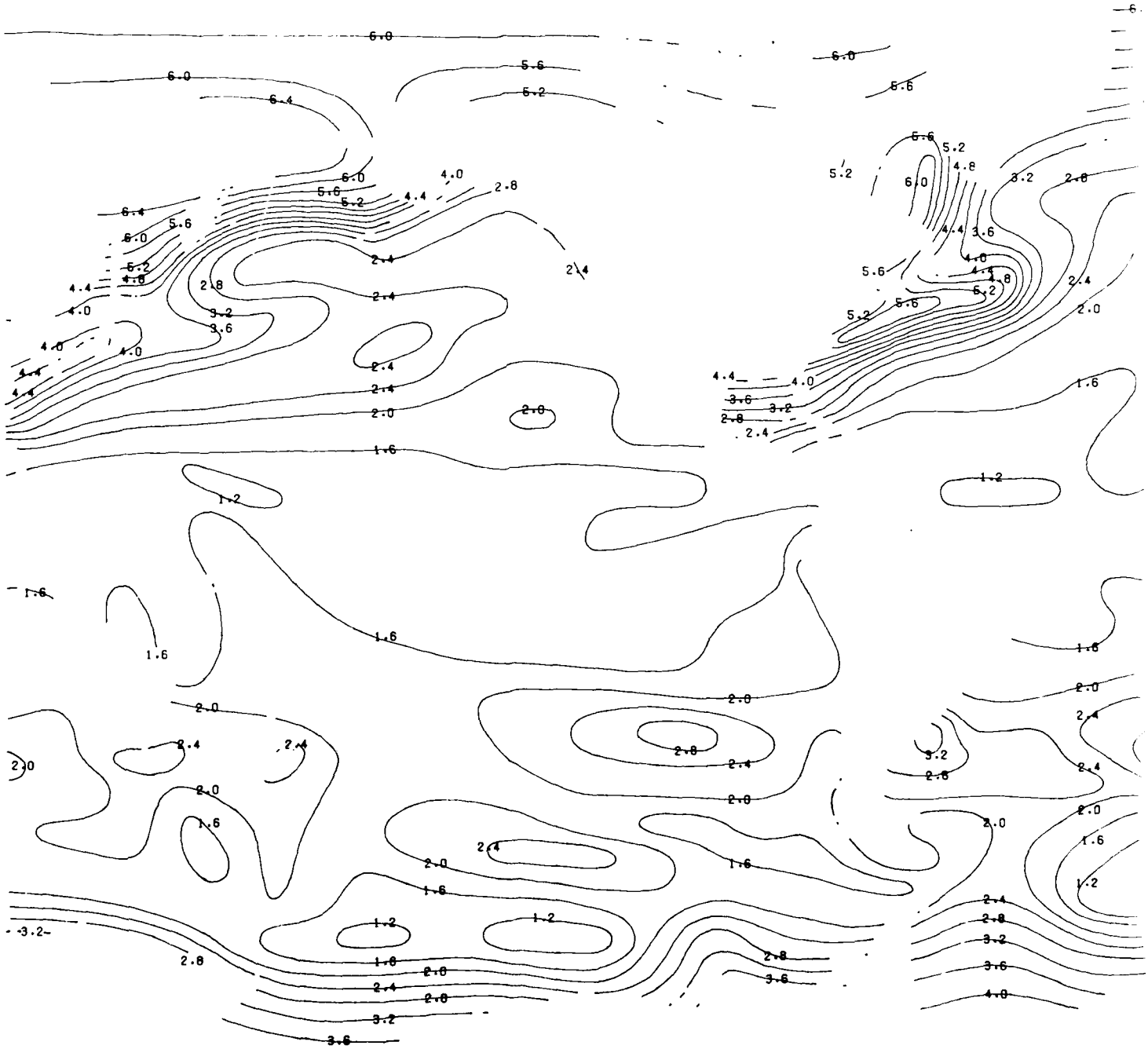

RD DEVIATIONS

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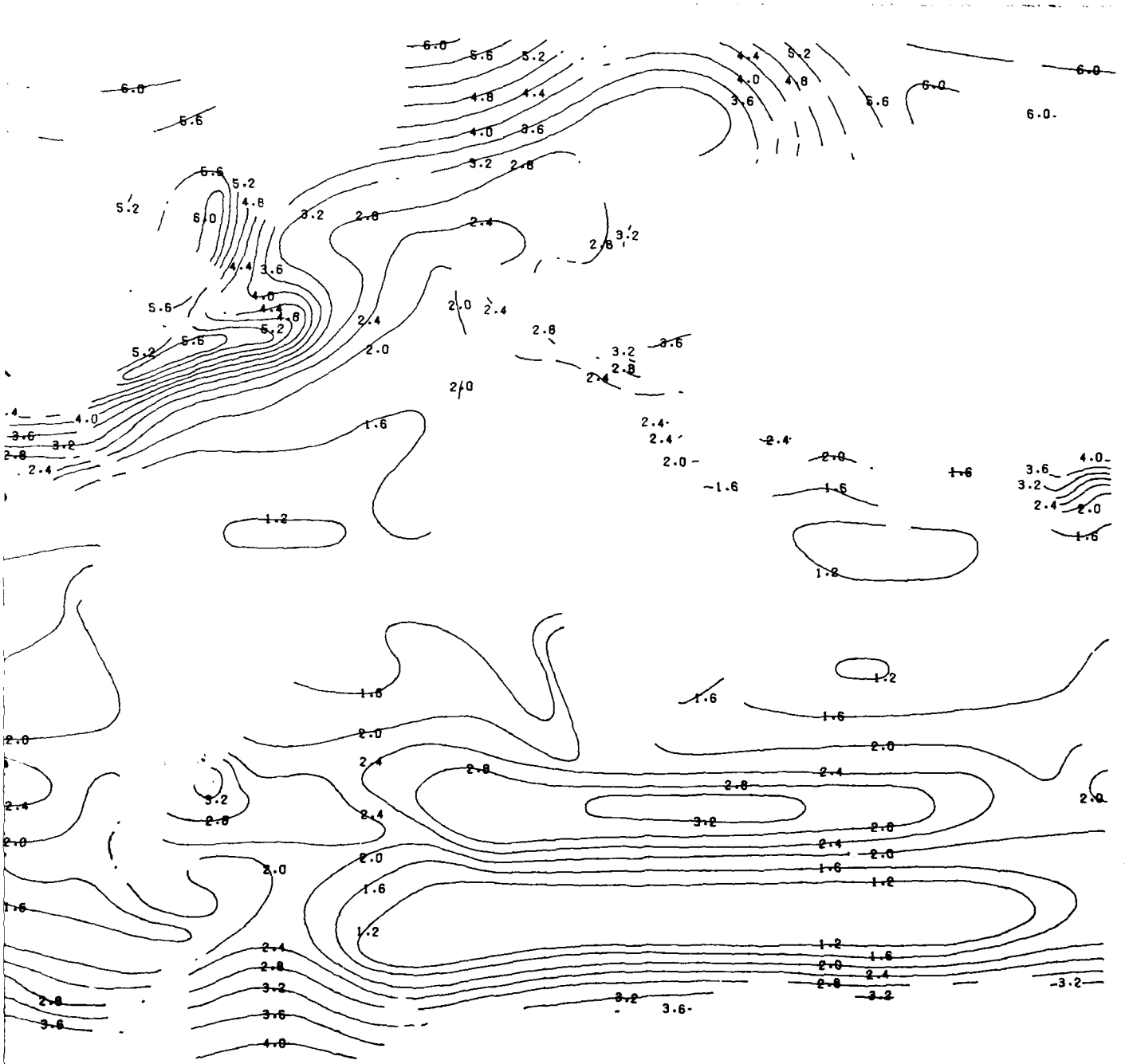

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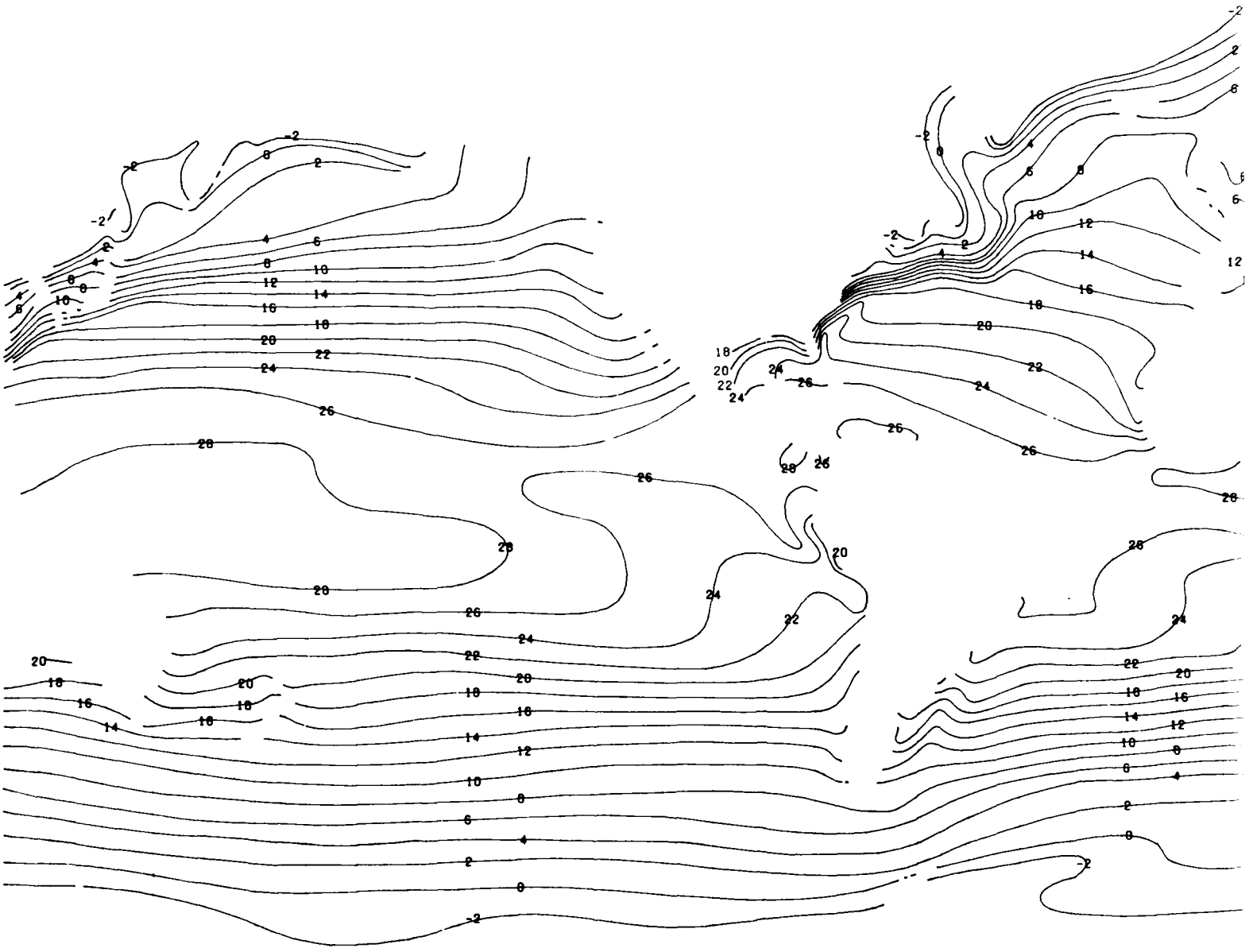

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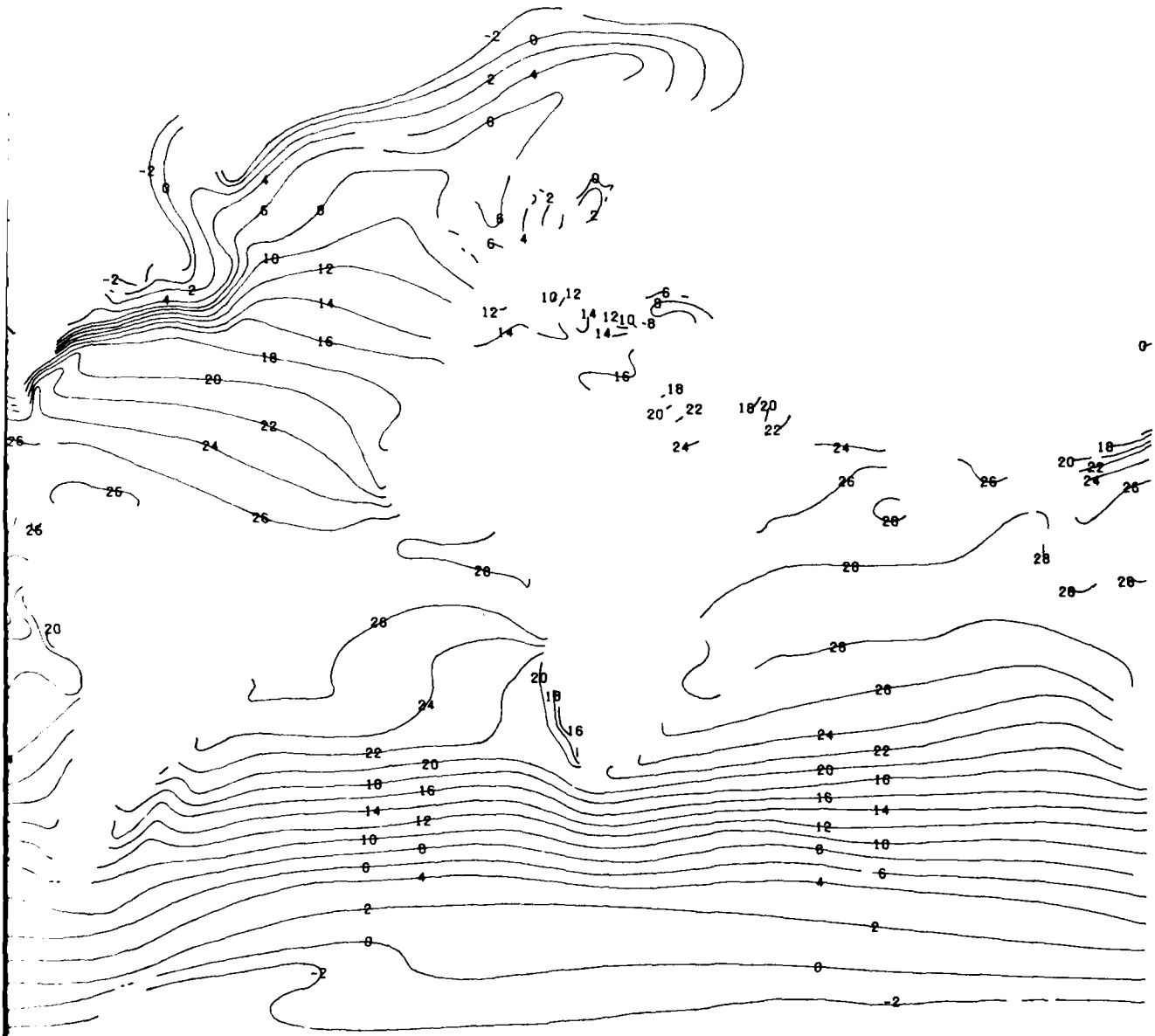

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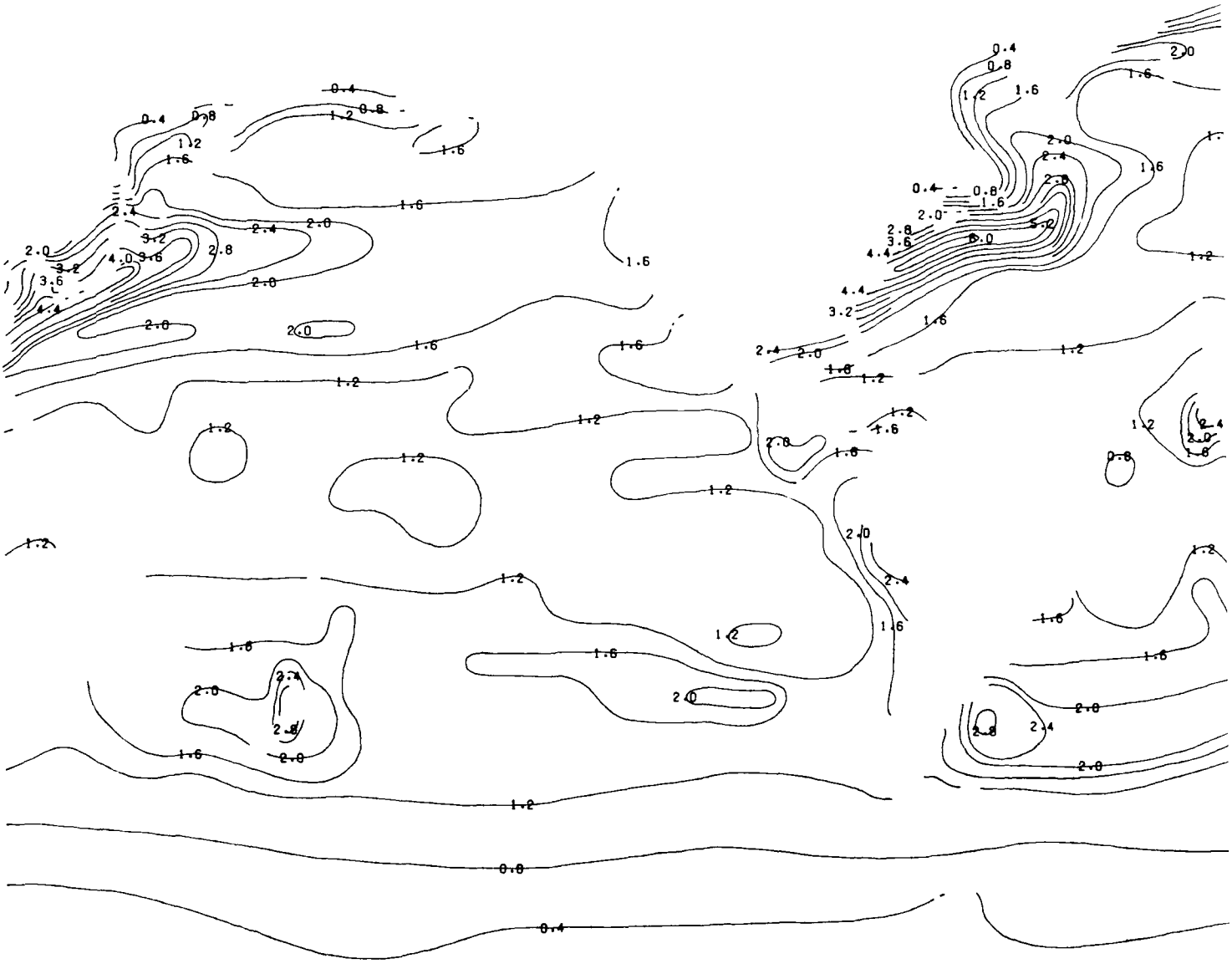

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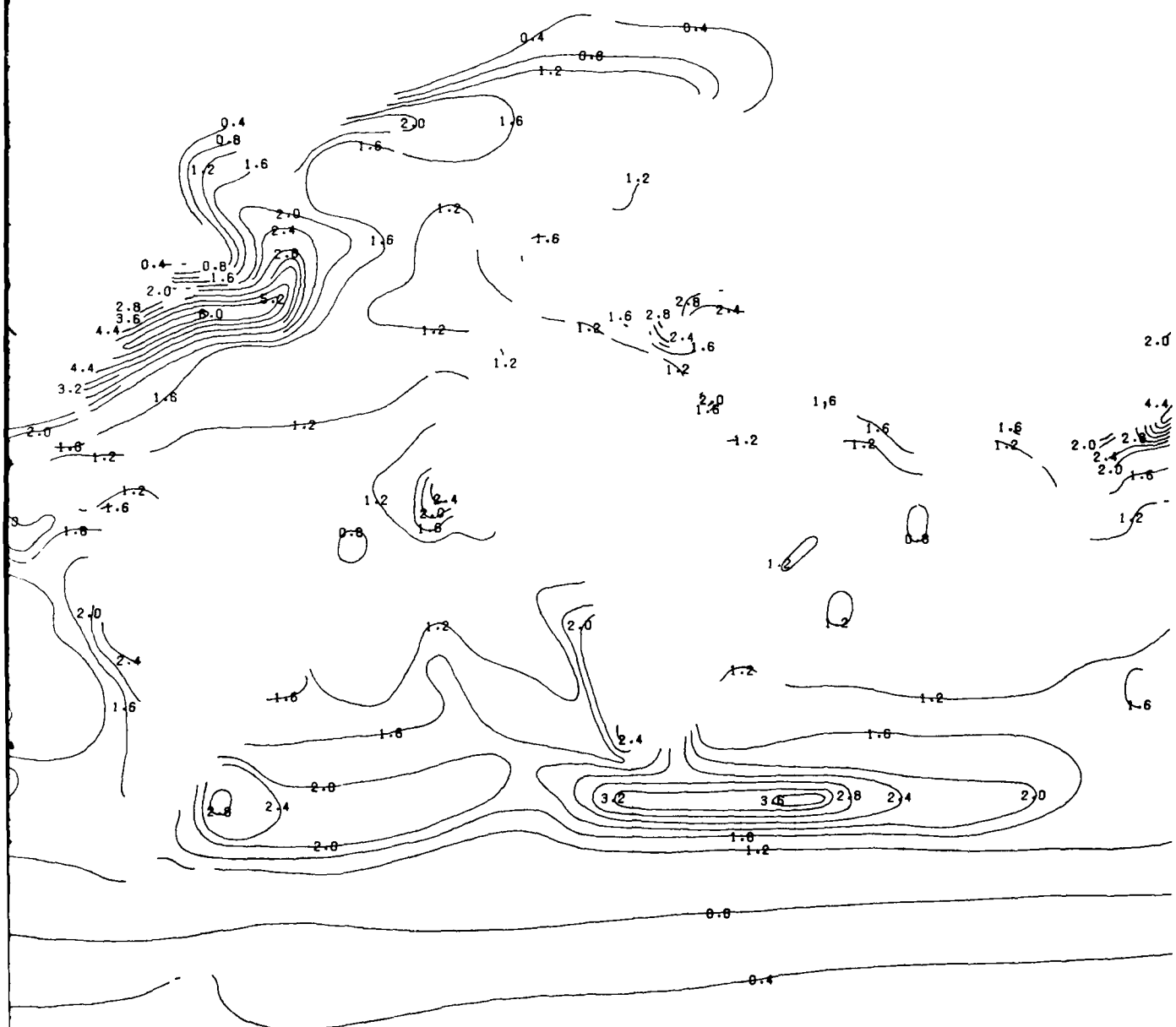

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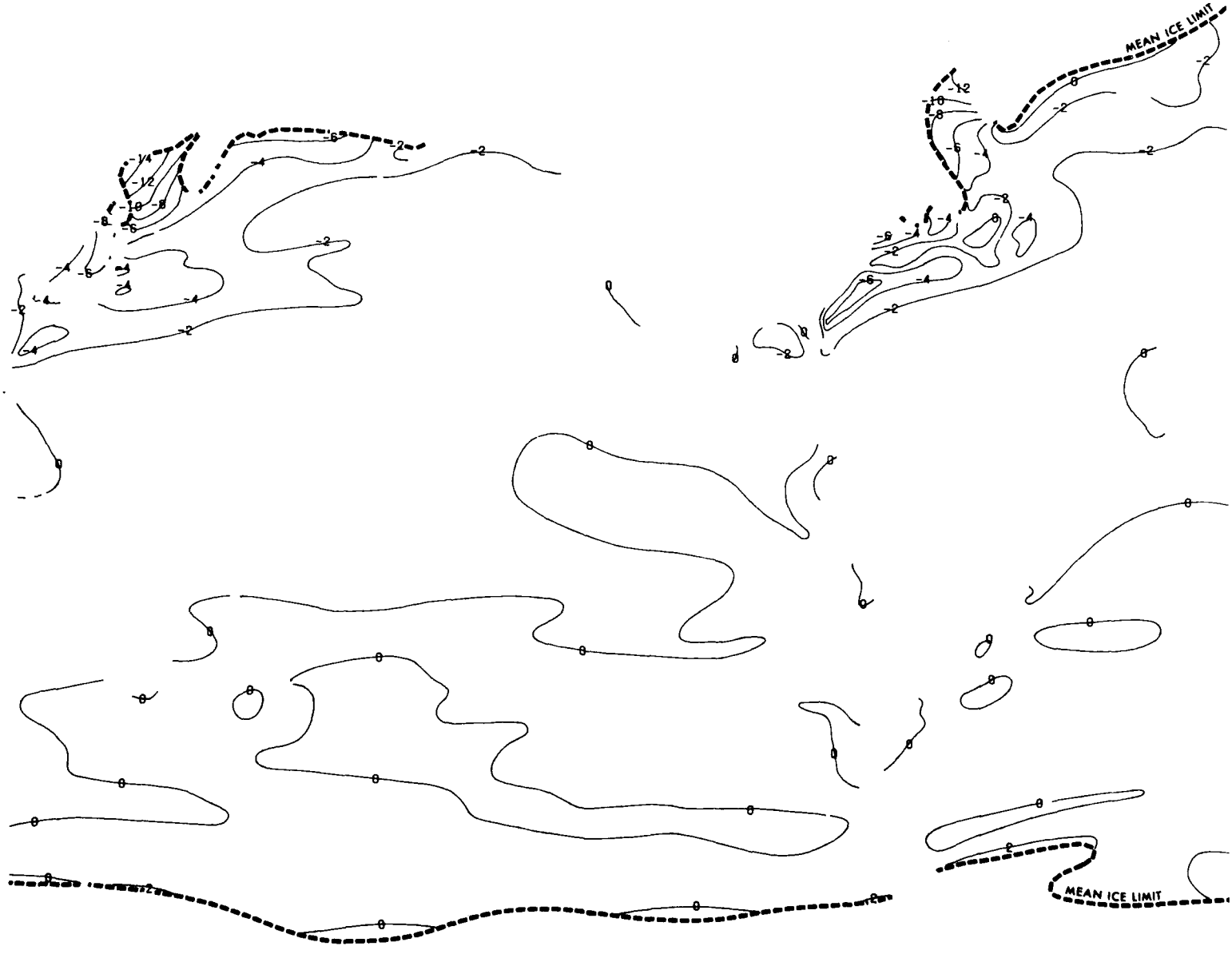

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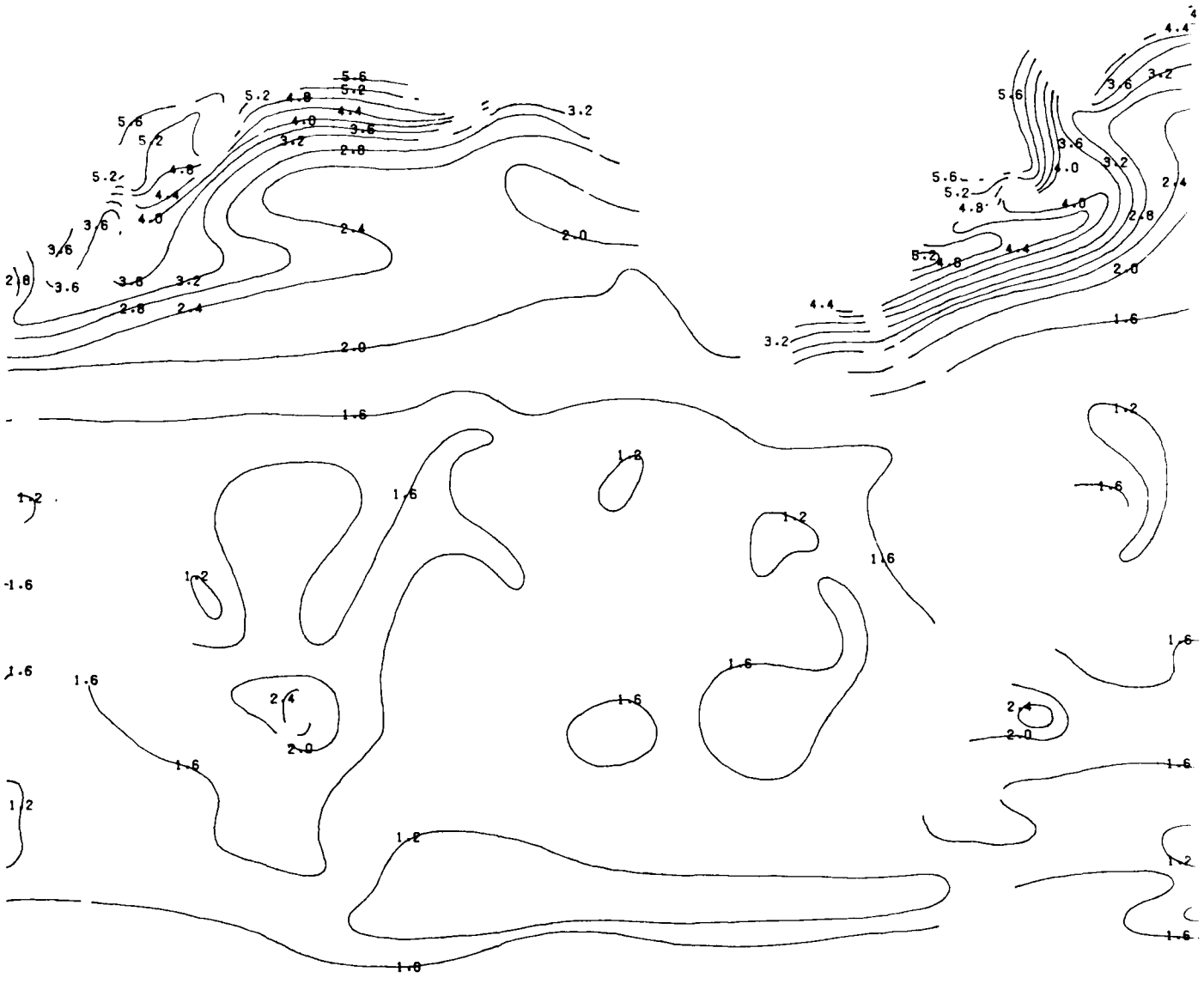
AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIONS



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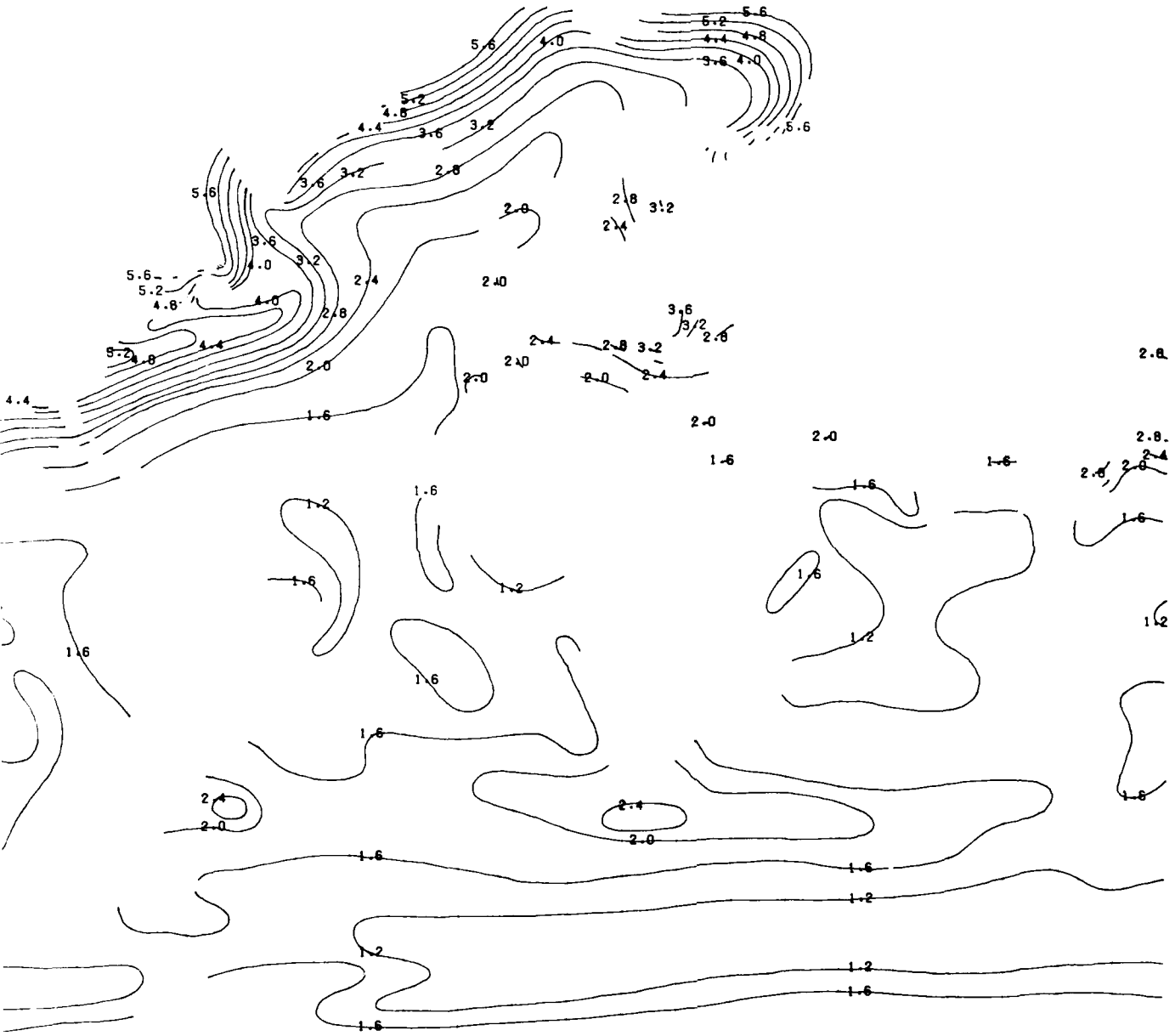

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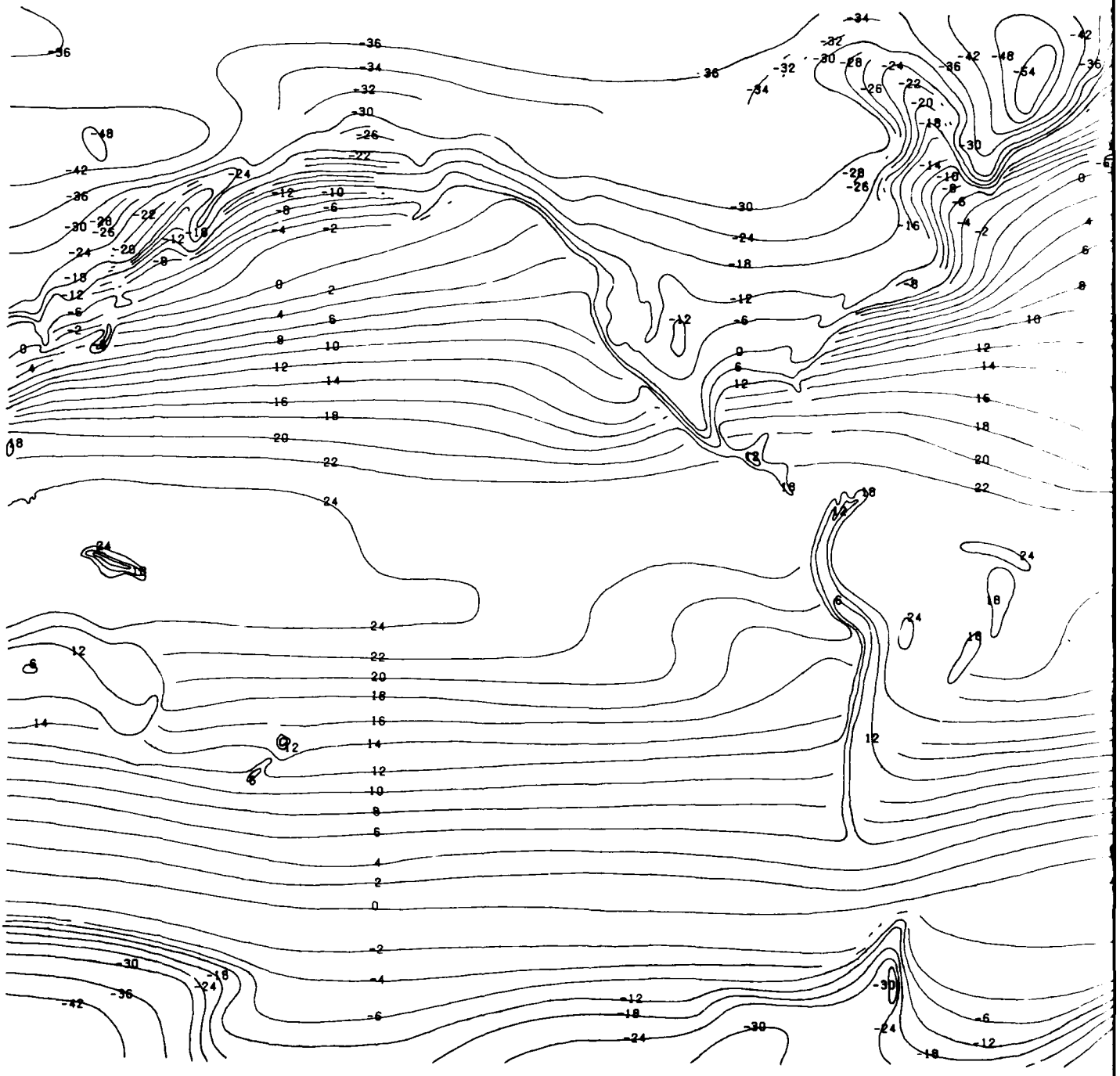
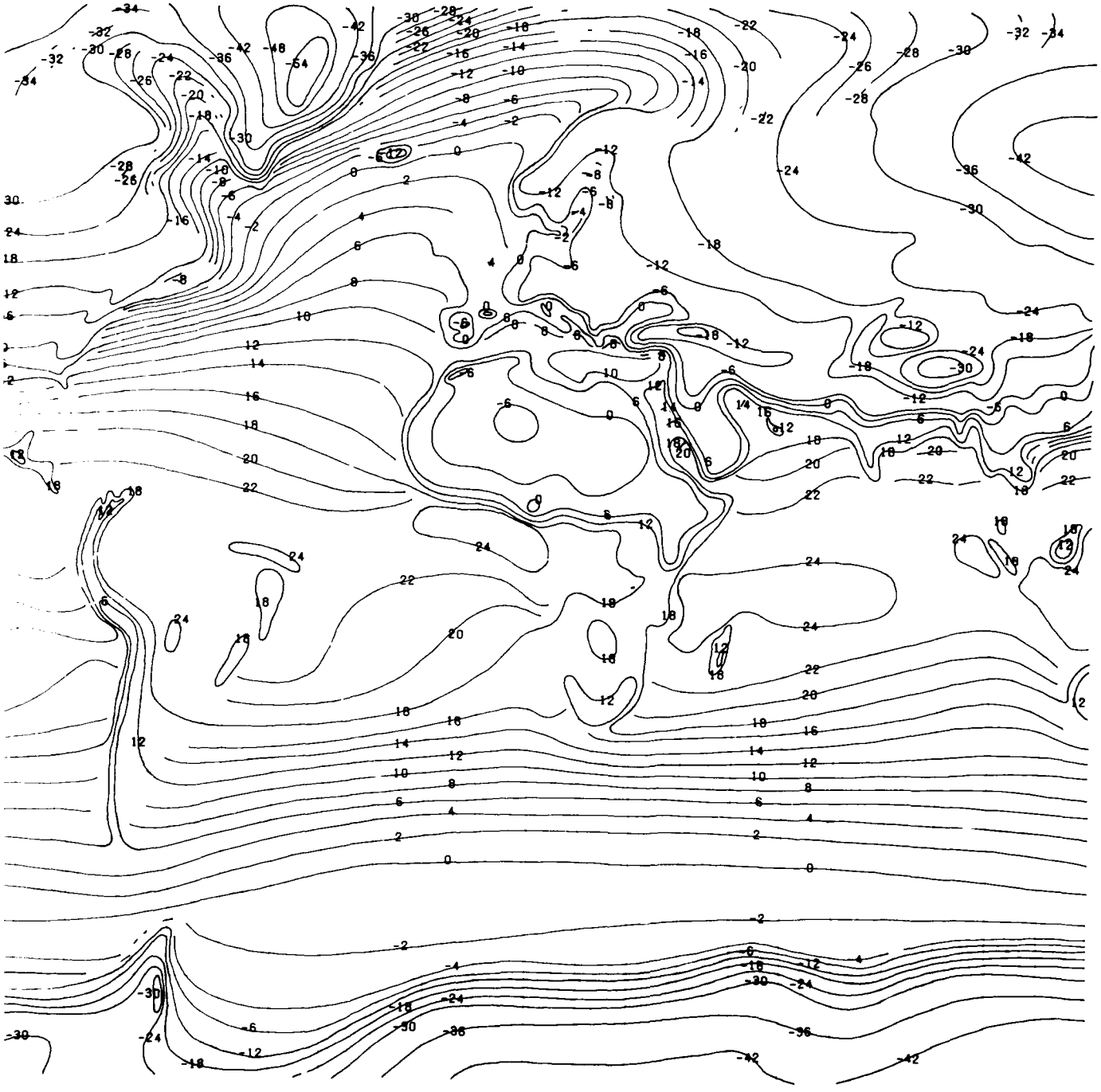
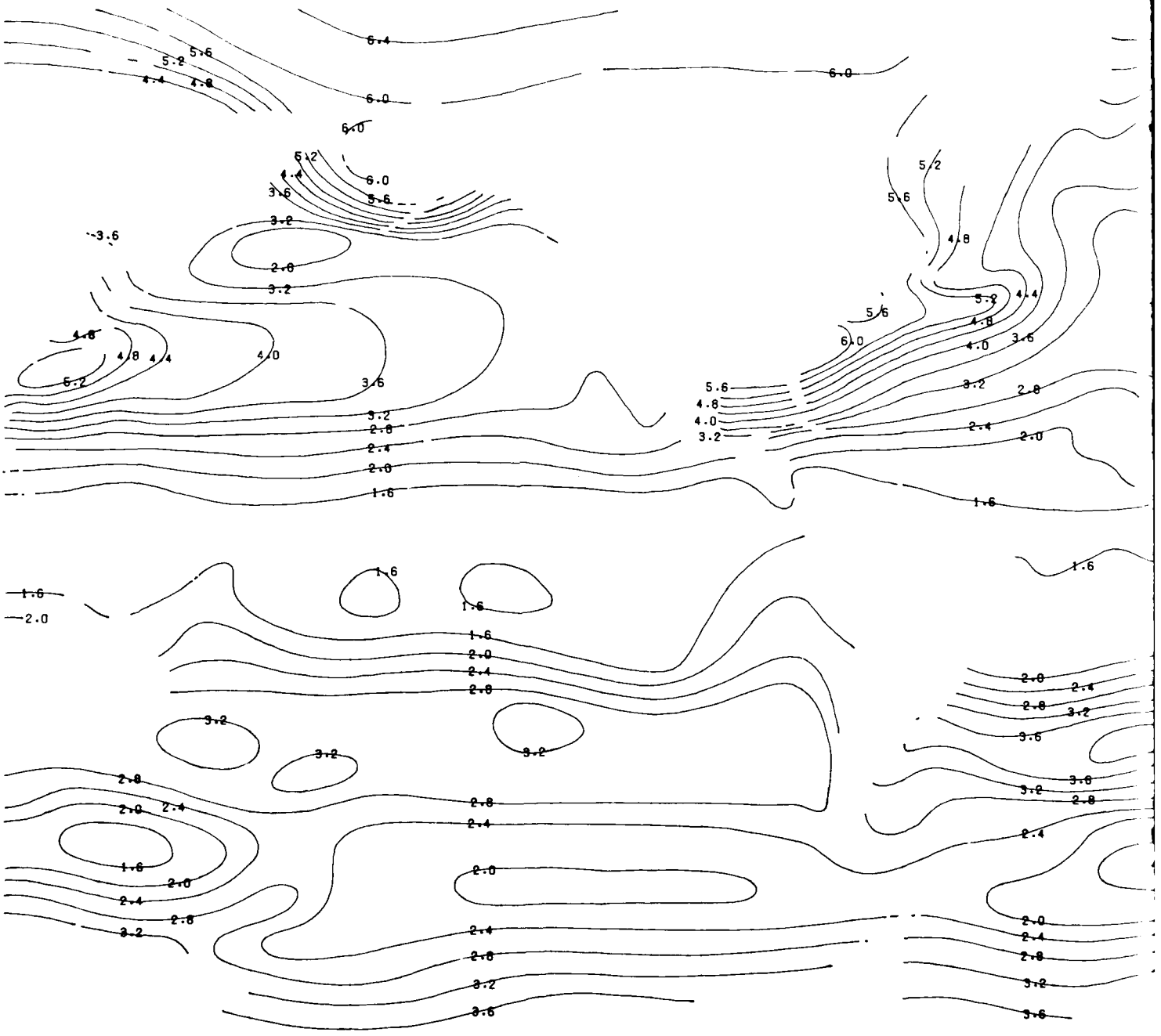


DEW-POINT TEMPERATURE (°C) - MEANS

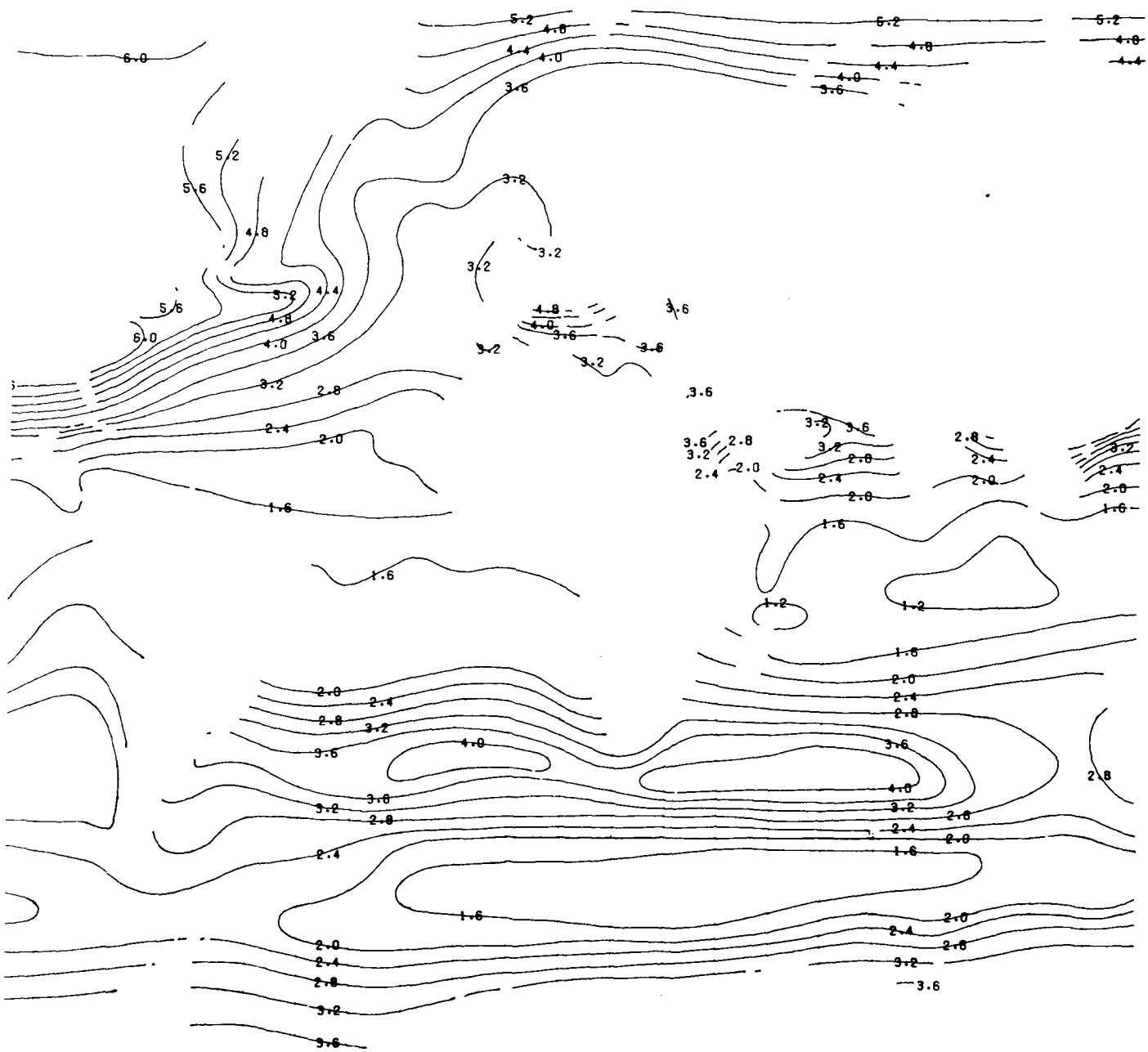


DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



DEVIATIONS

FEBRUARY



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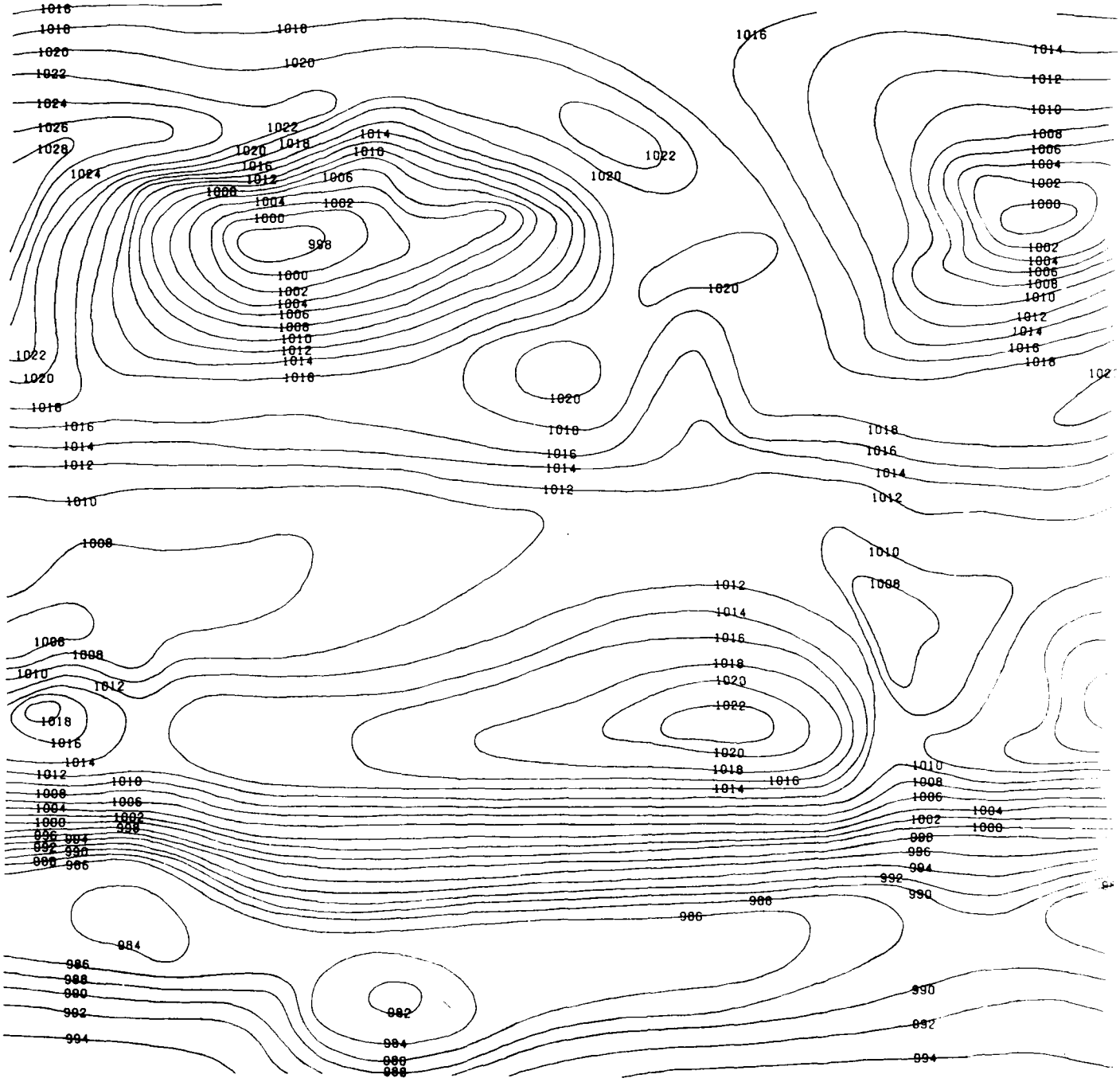
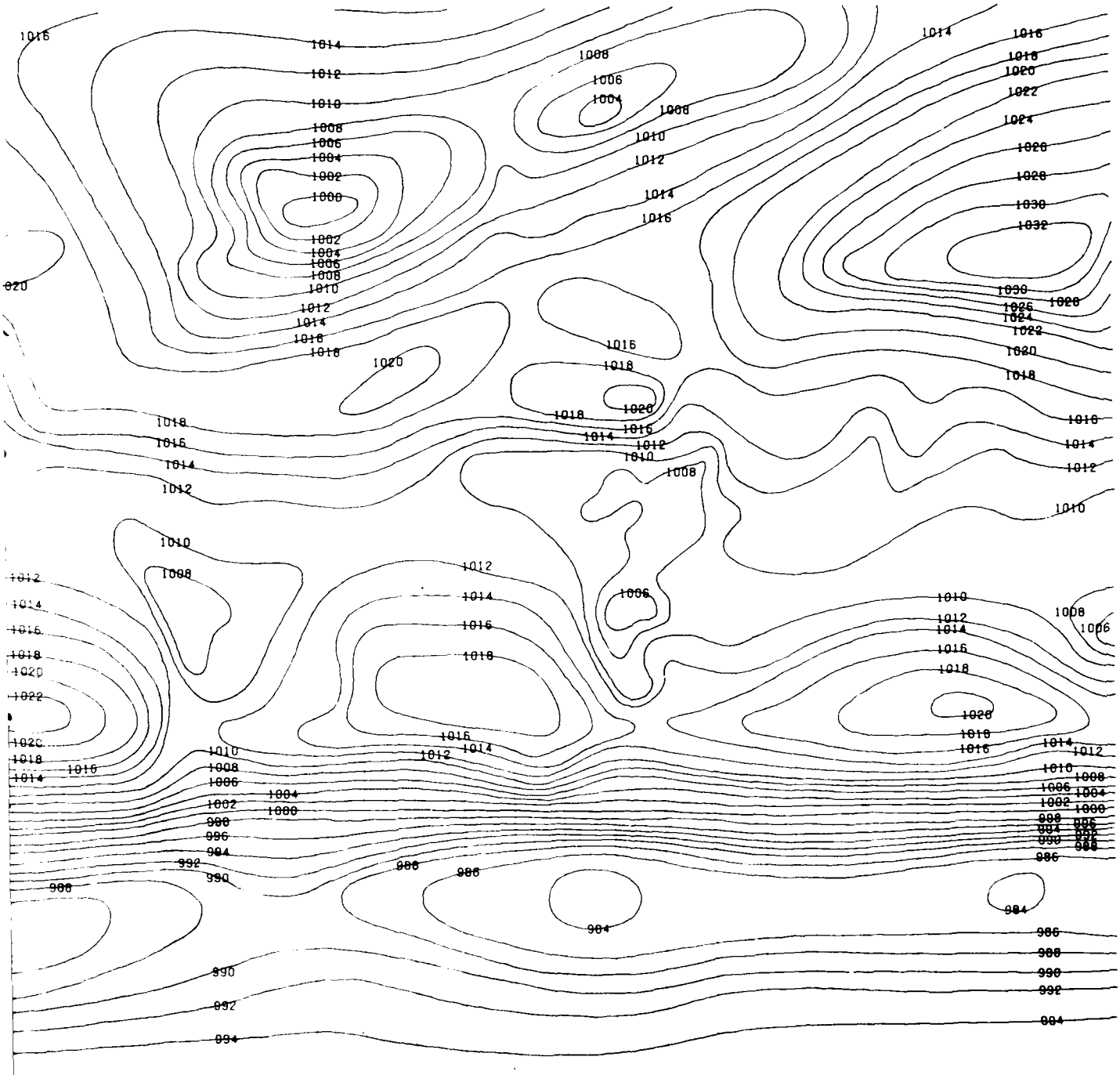
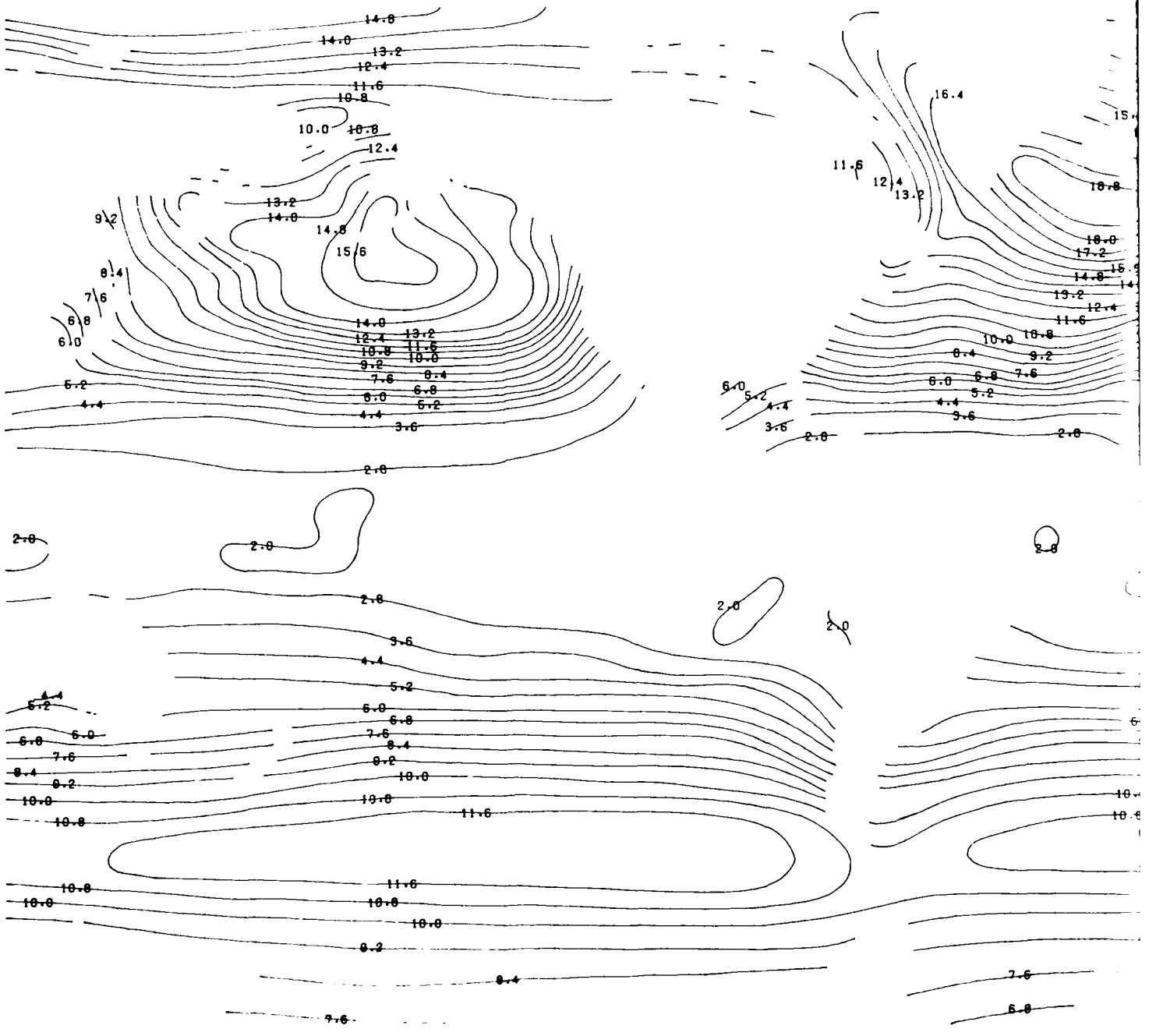
FEBRUARY



SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



EVIATIONS

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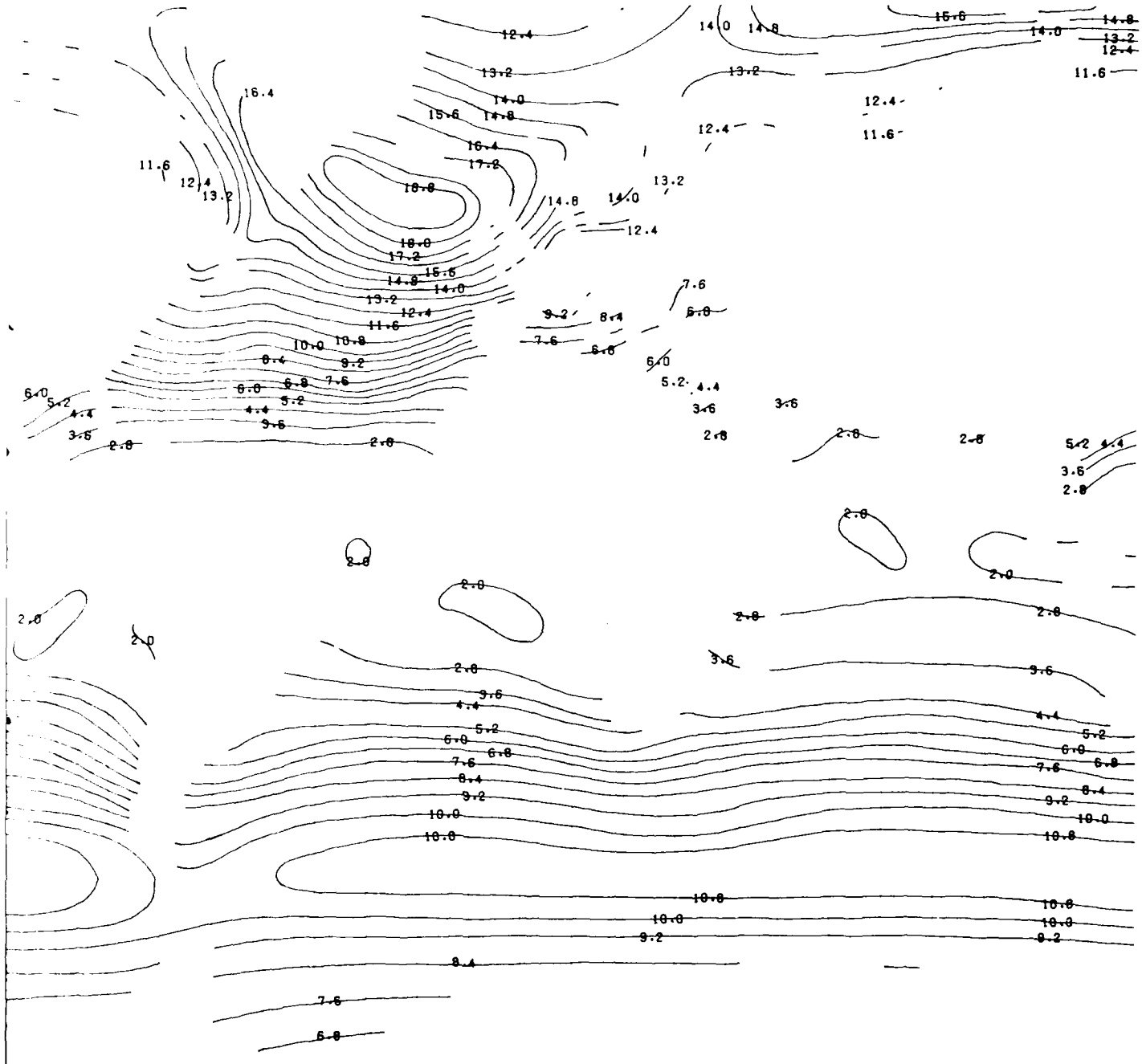

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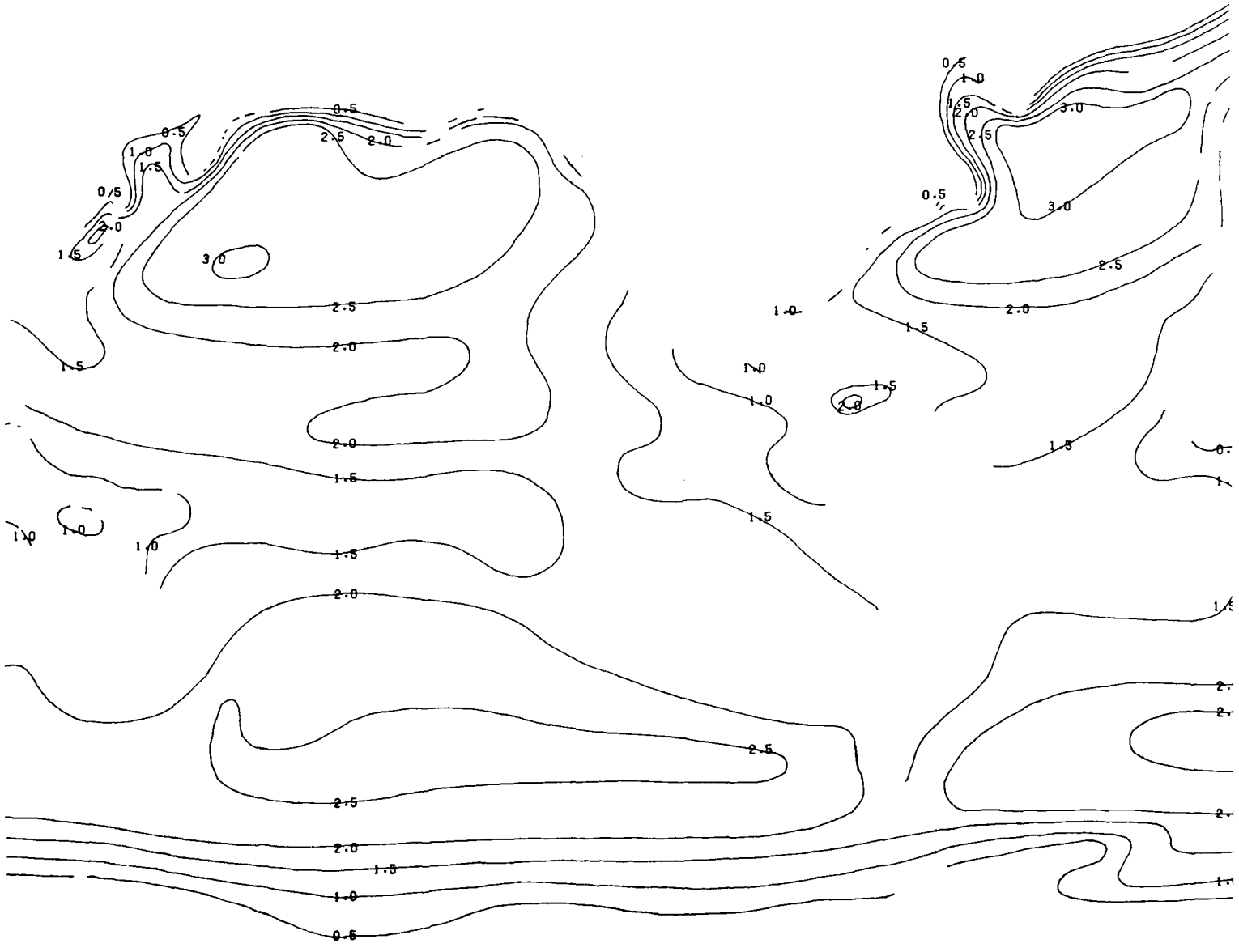
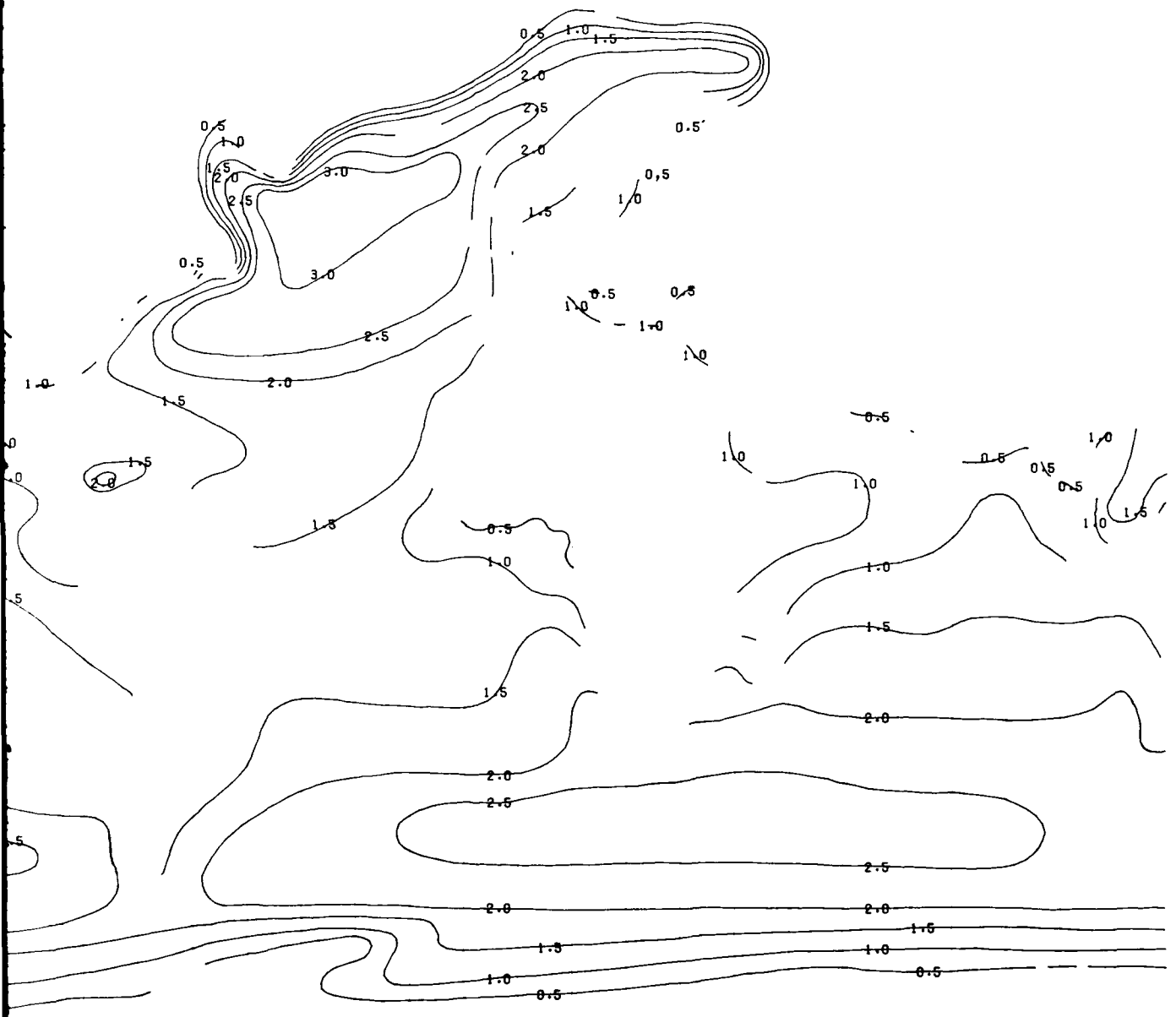
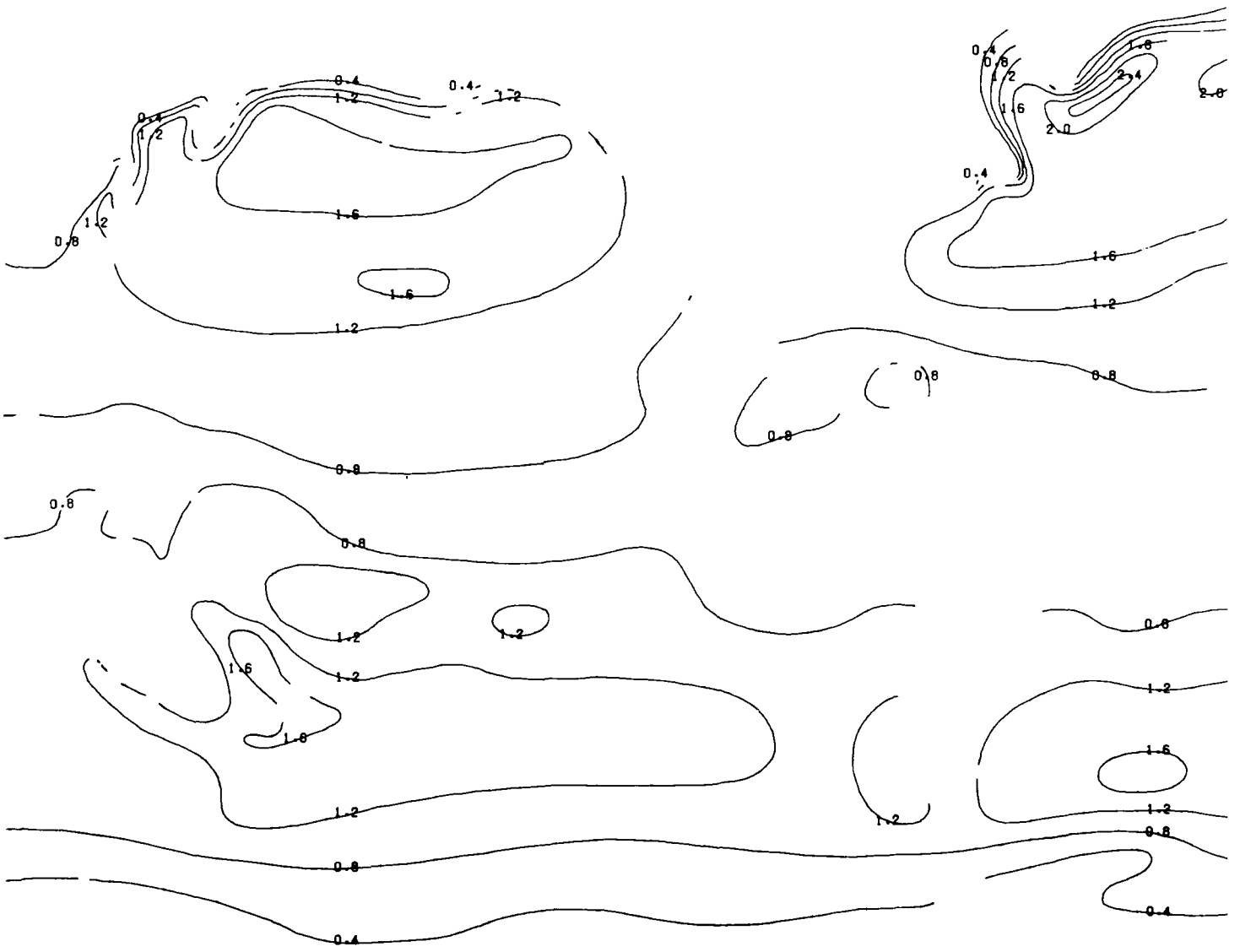


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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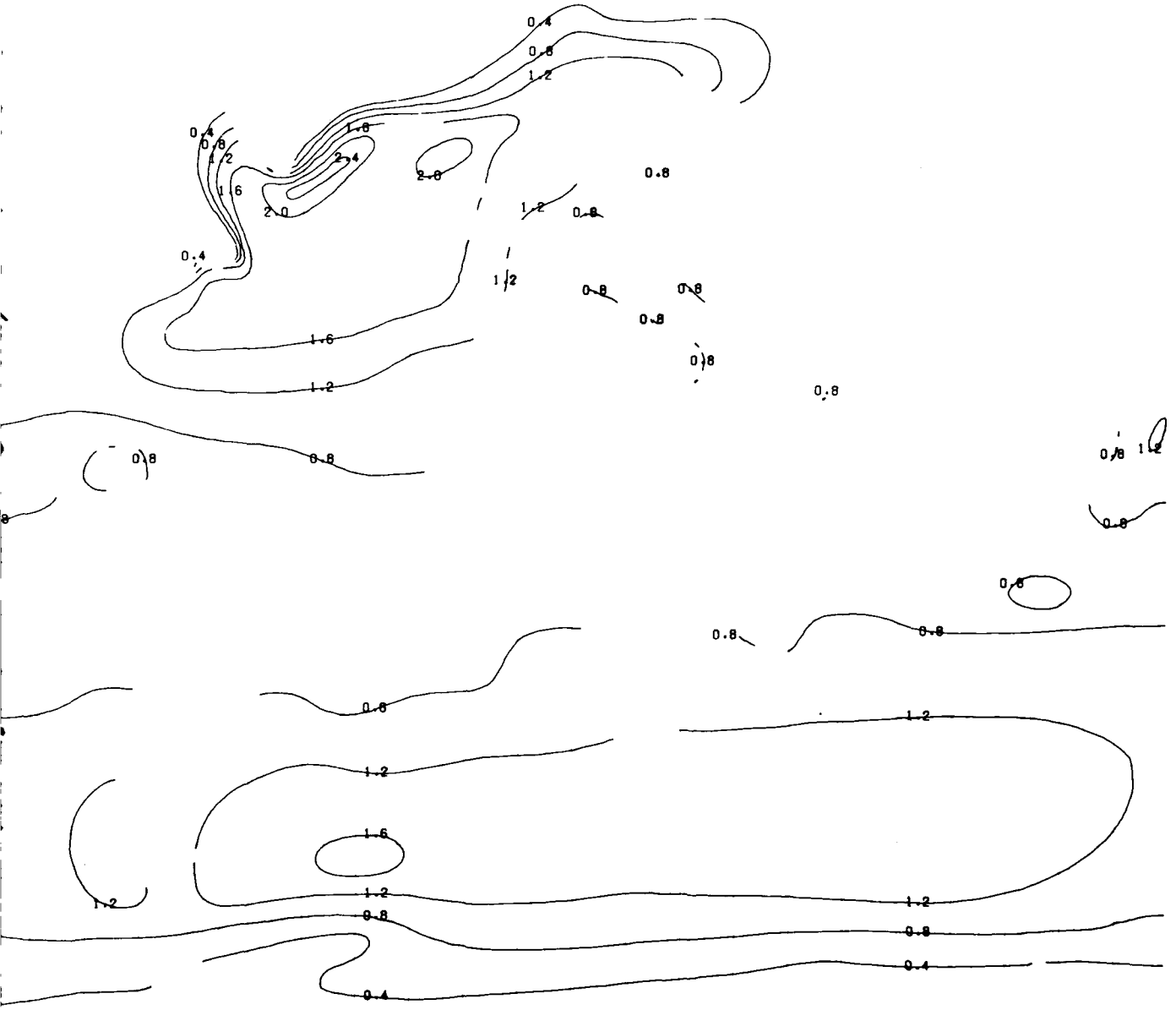

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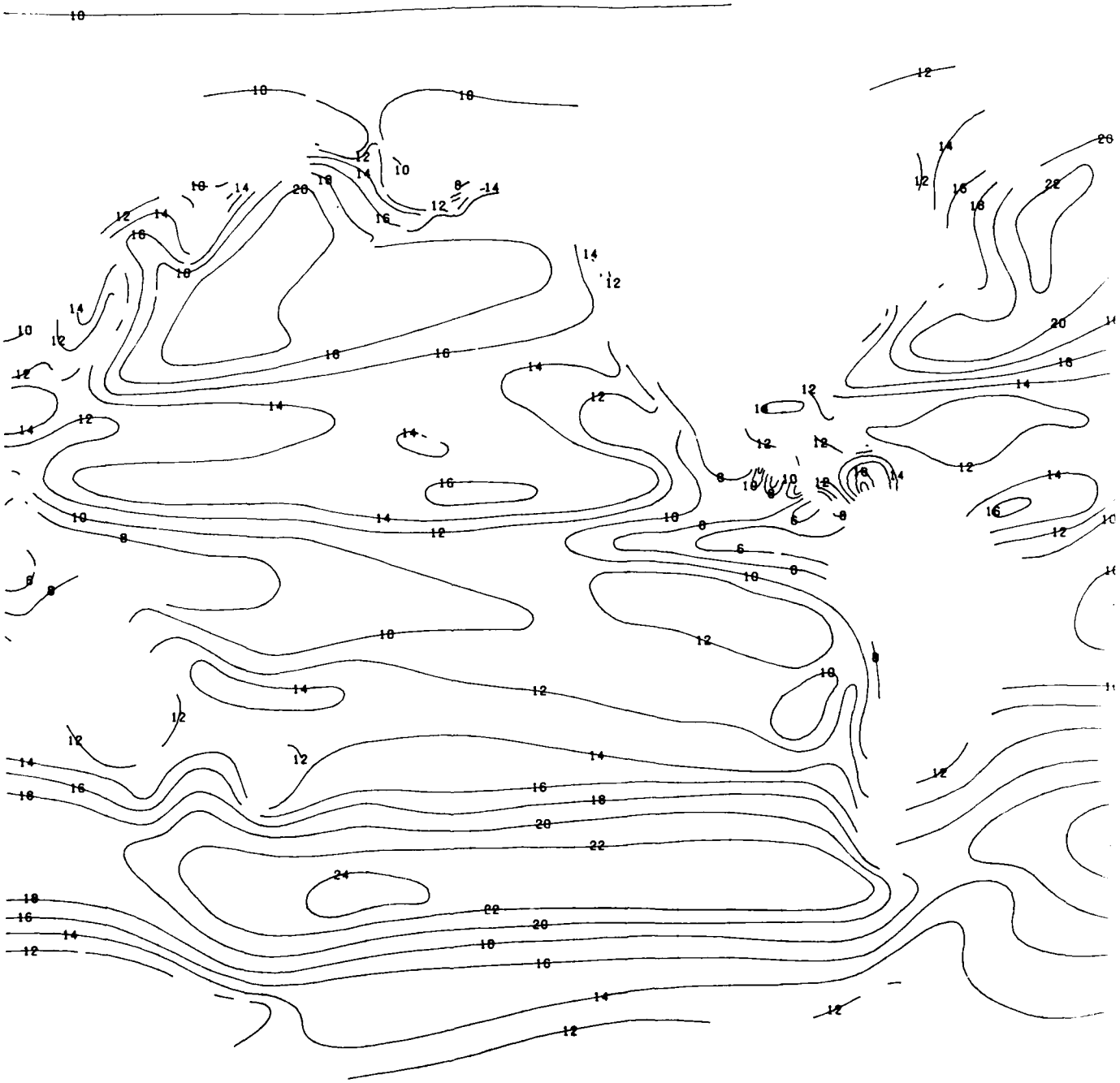
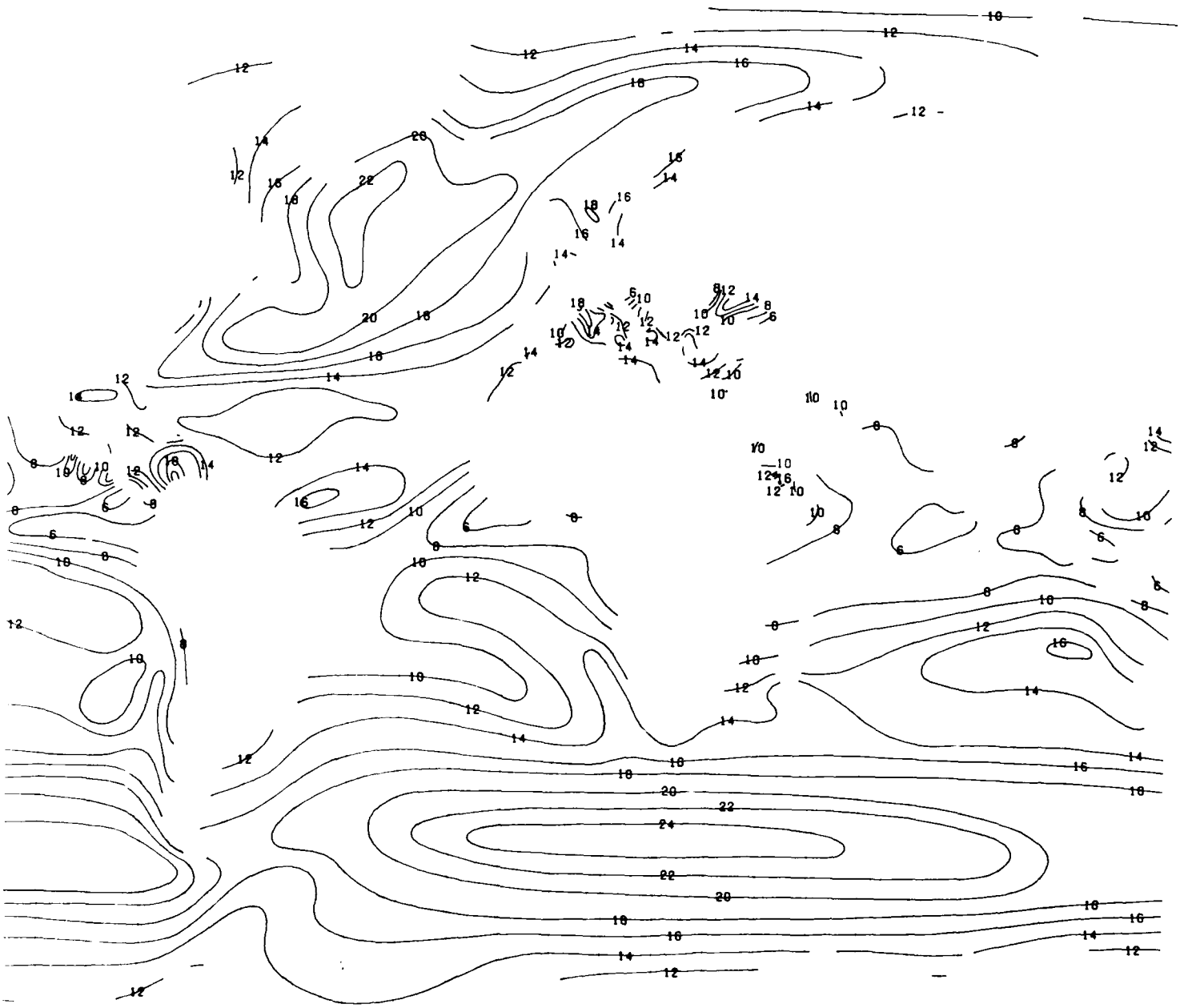
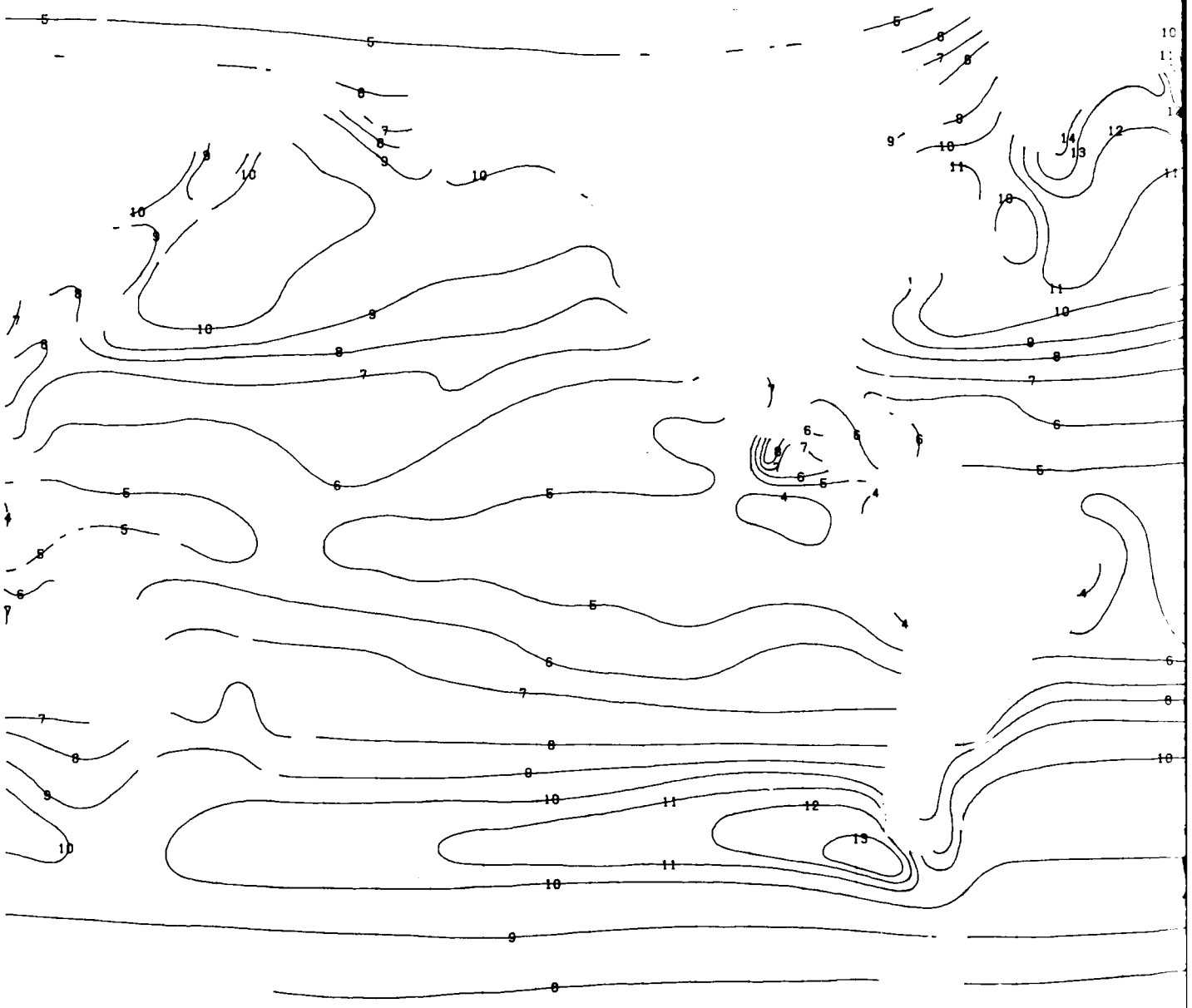
MARCH



SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



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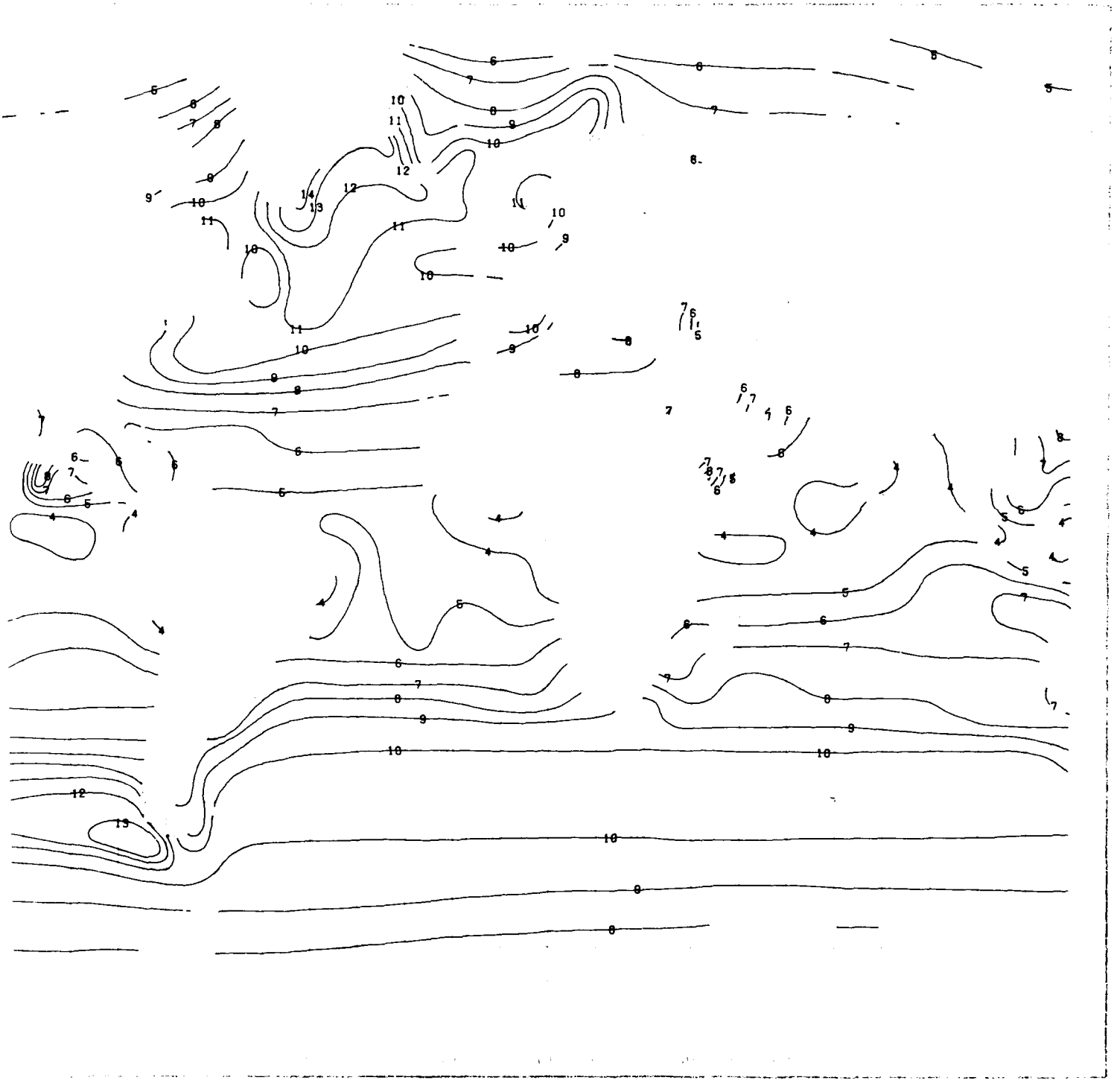

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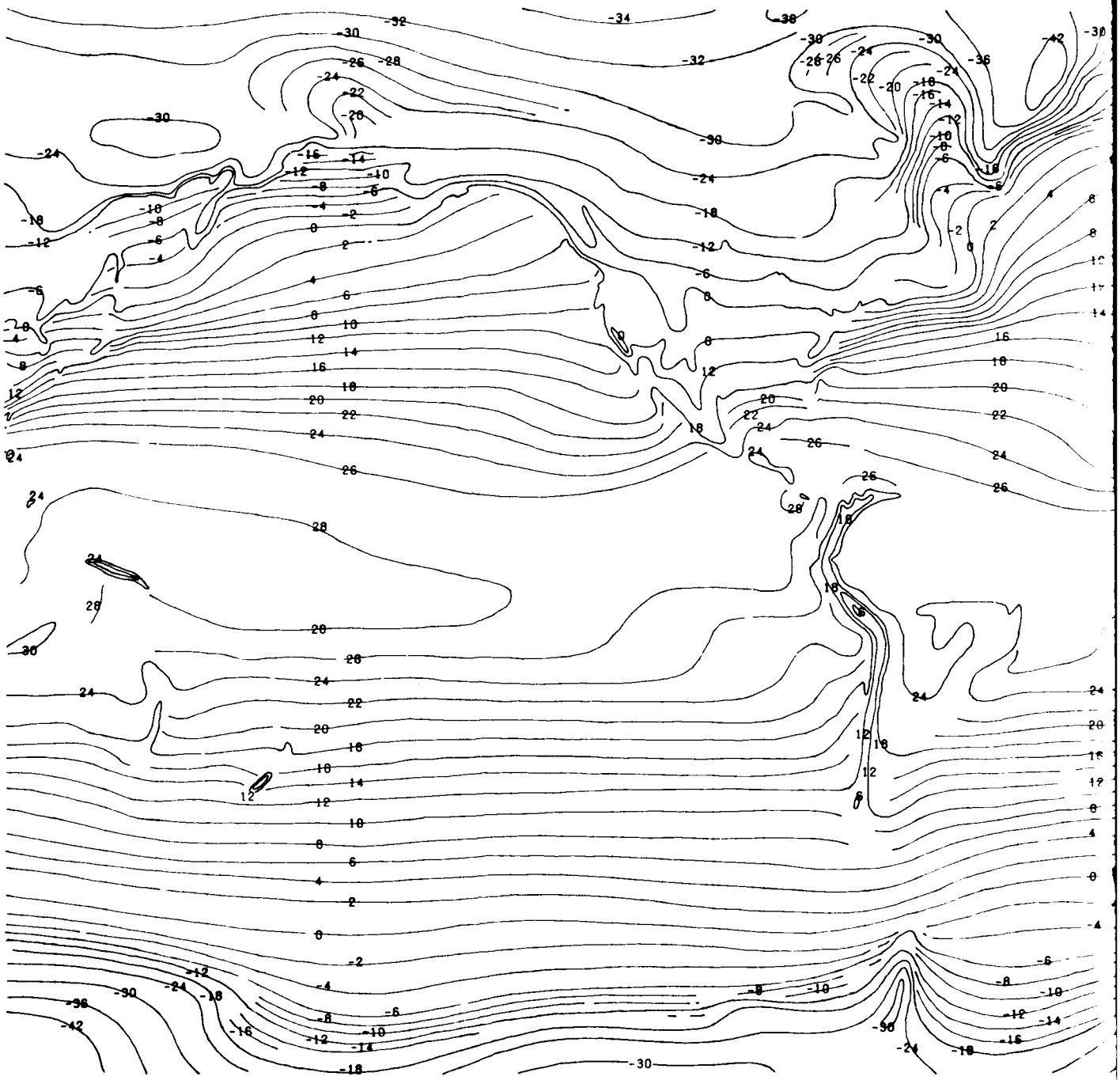
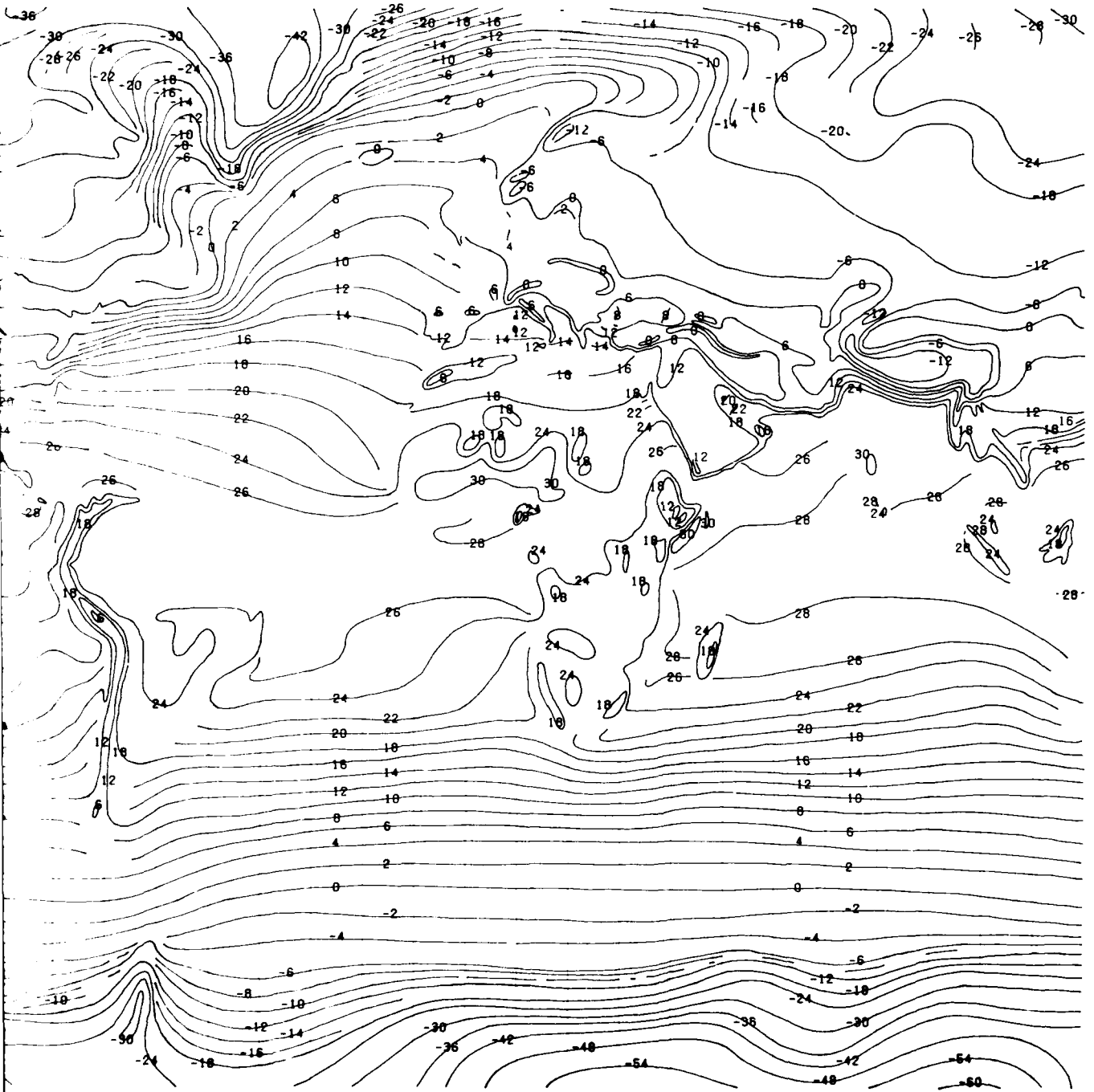
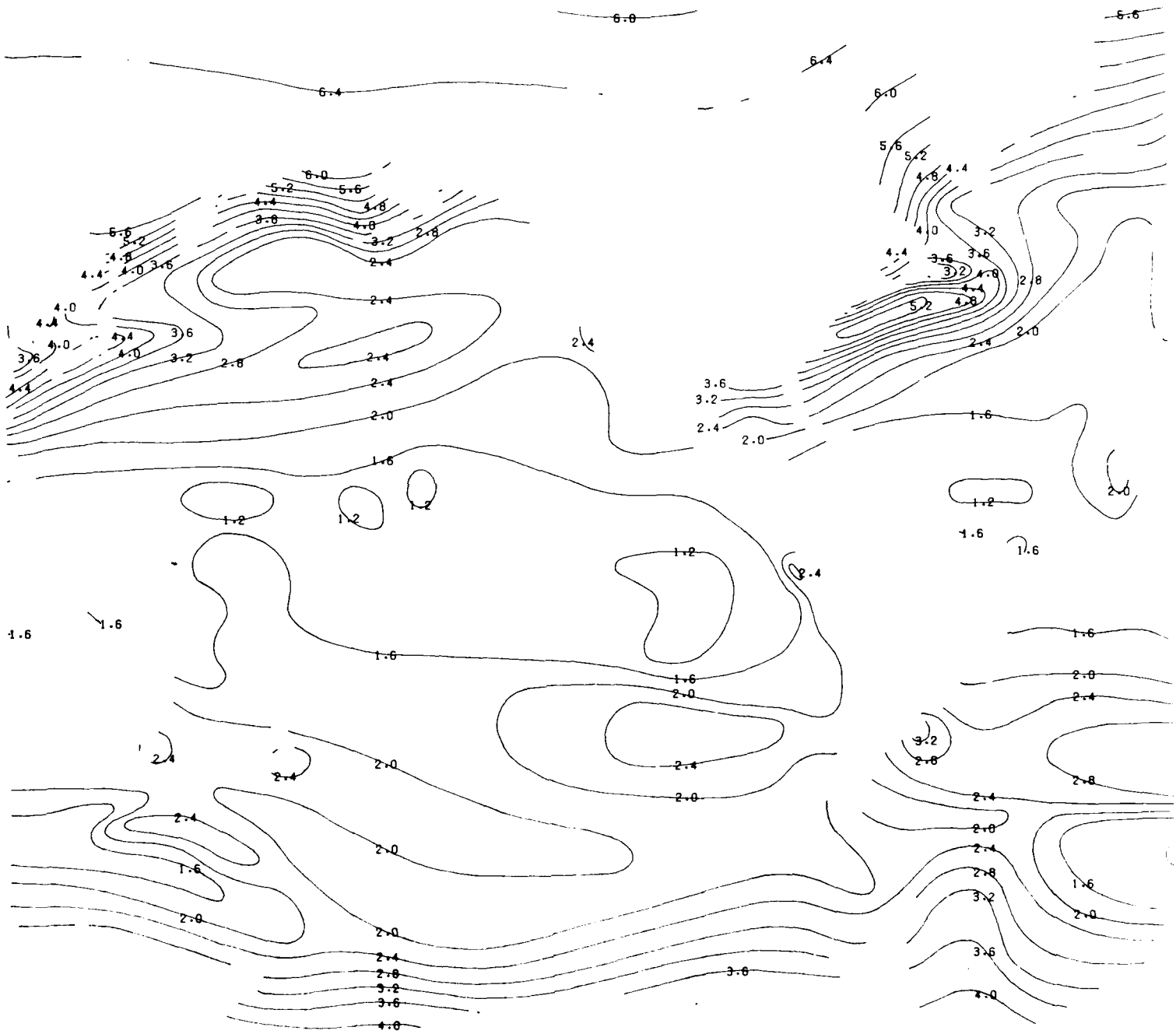


SURFACE AIR TEMPERATURE (°C) - MEANS

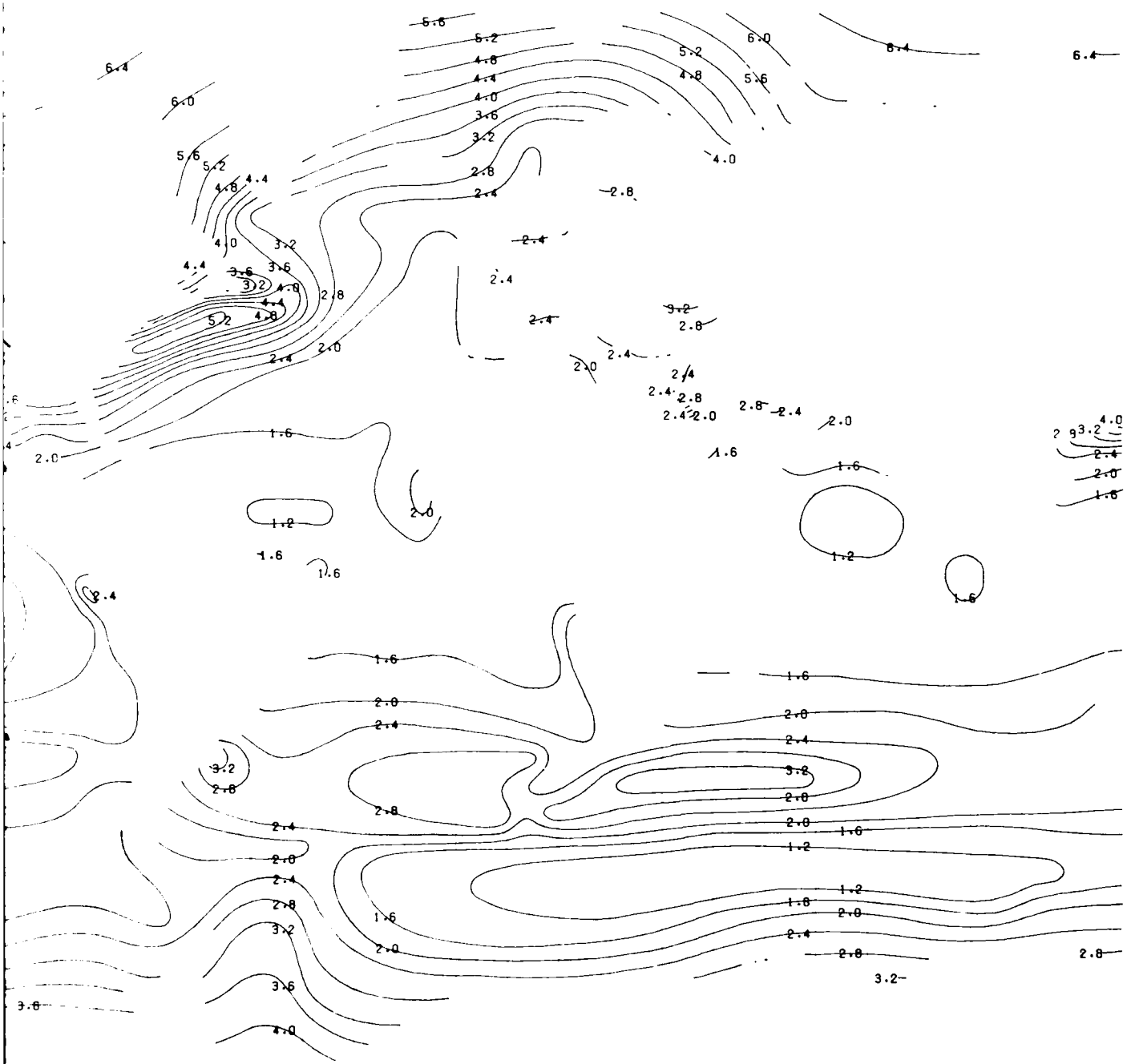


SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



RD DEVIATIONS

MARCH



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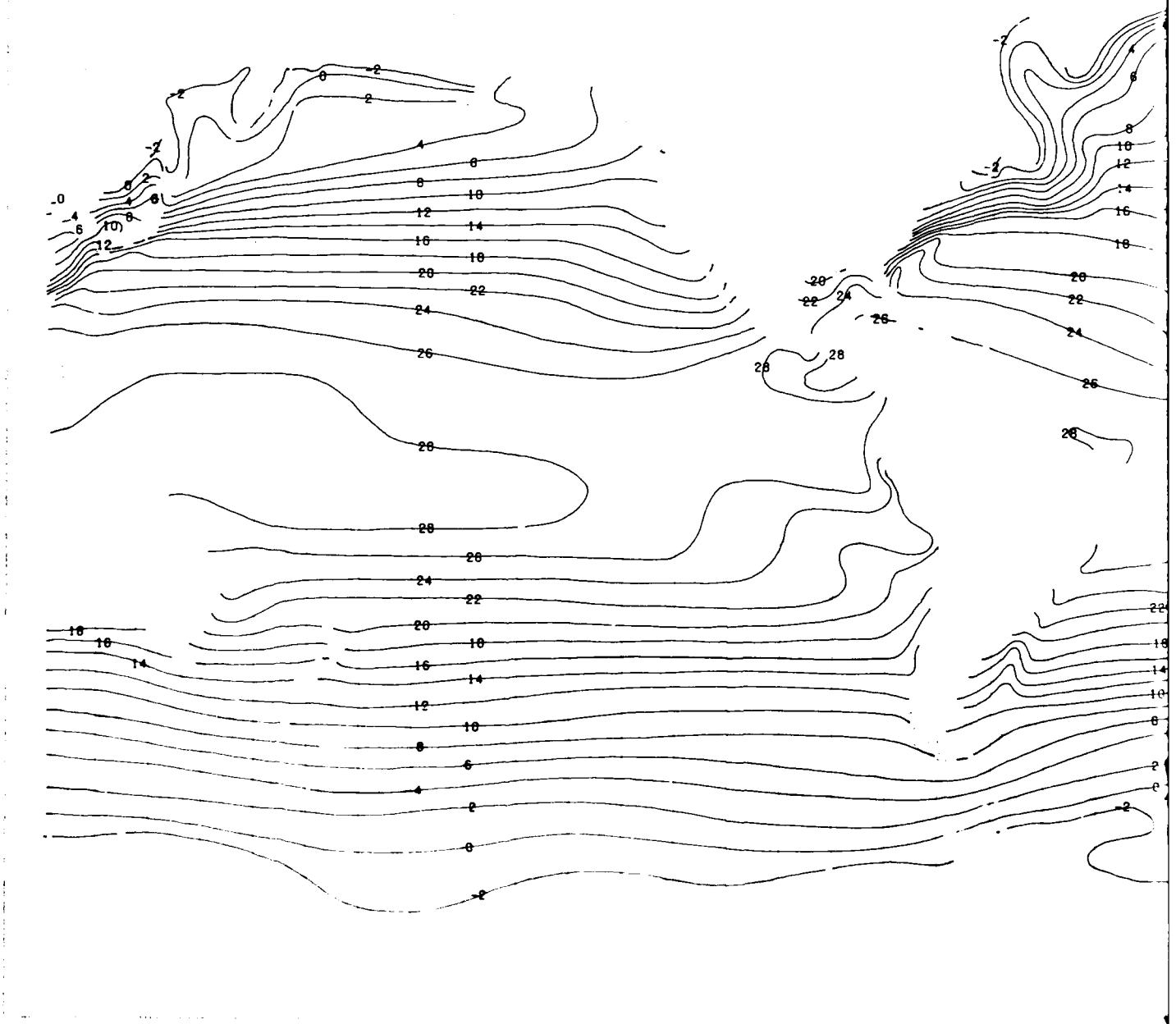
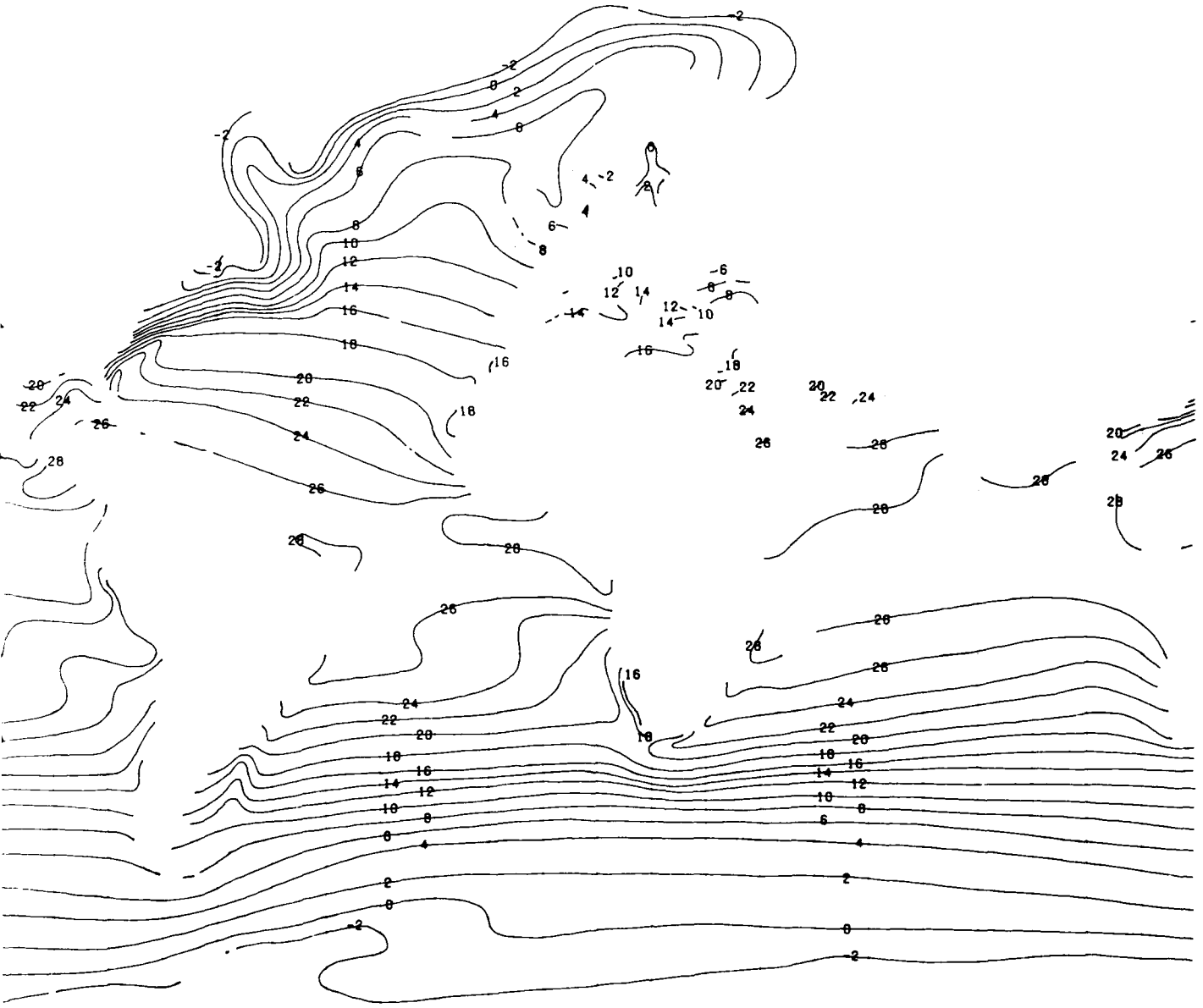
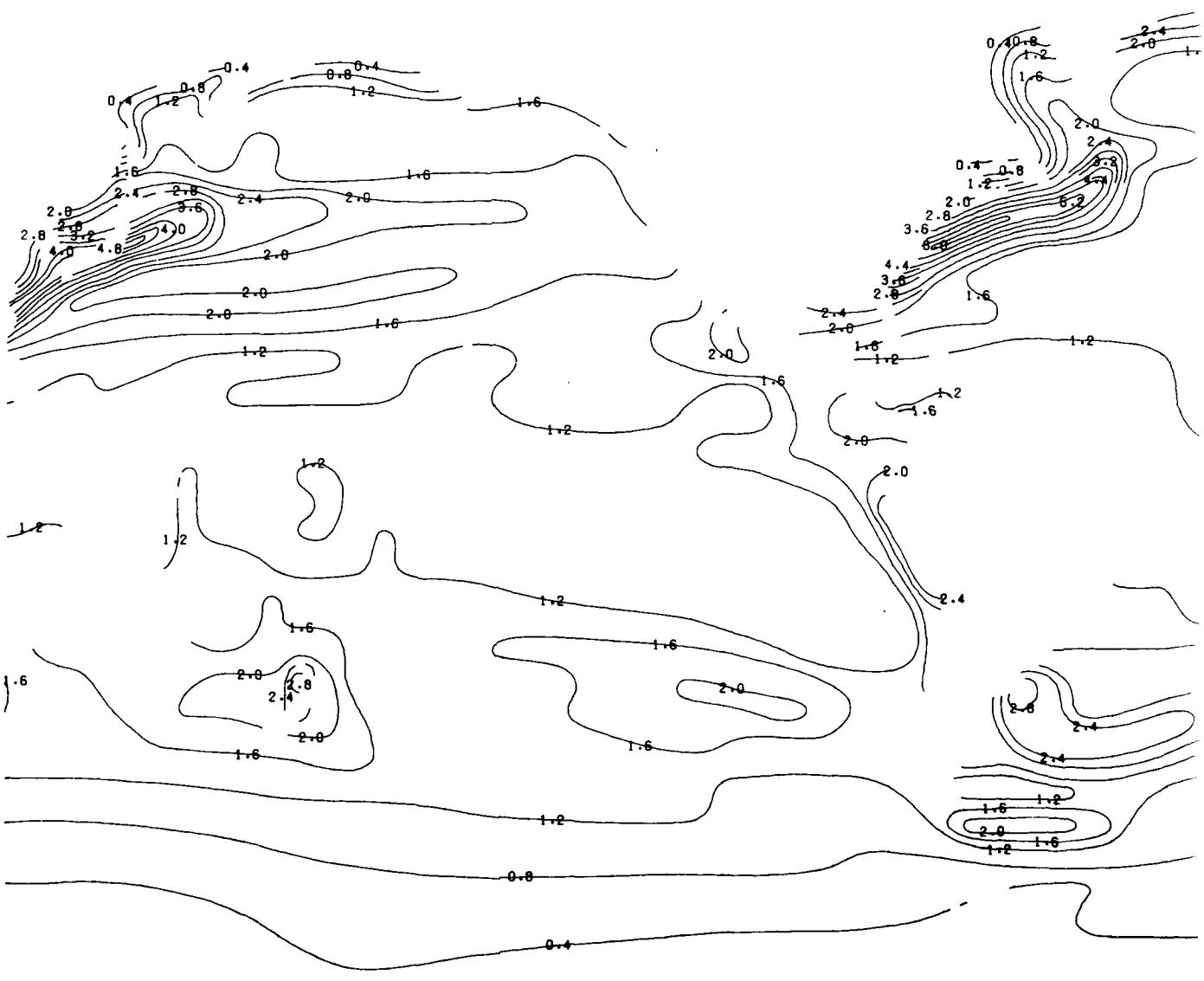


SEA SURFACE TEMPERATURE (°C) - MEANS

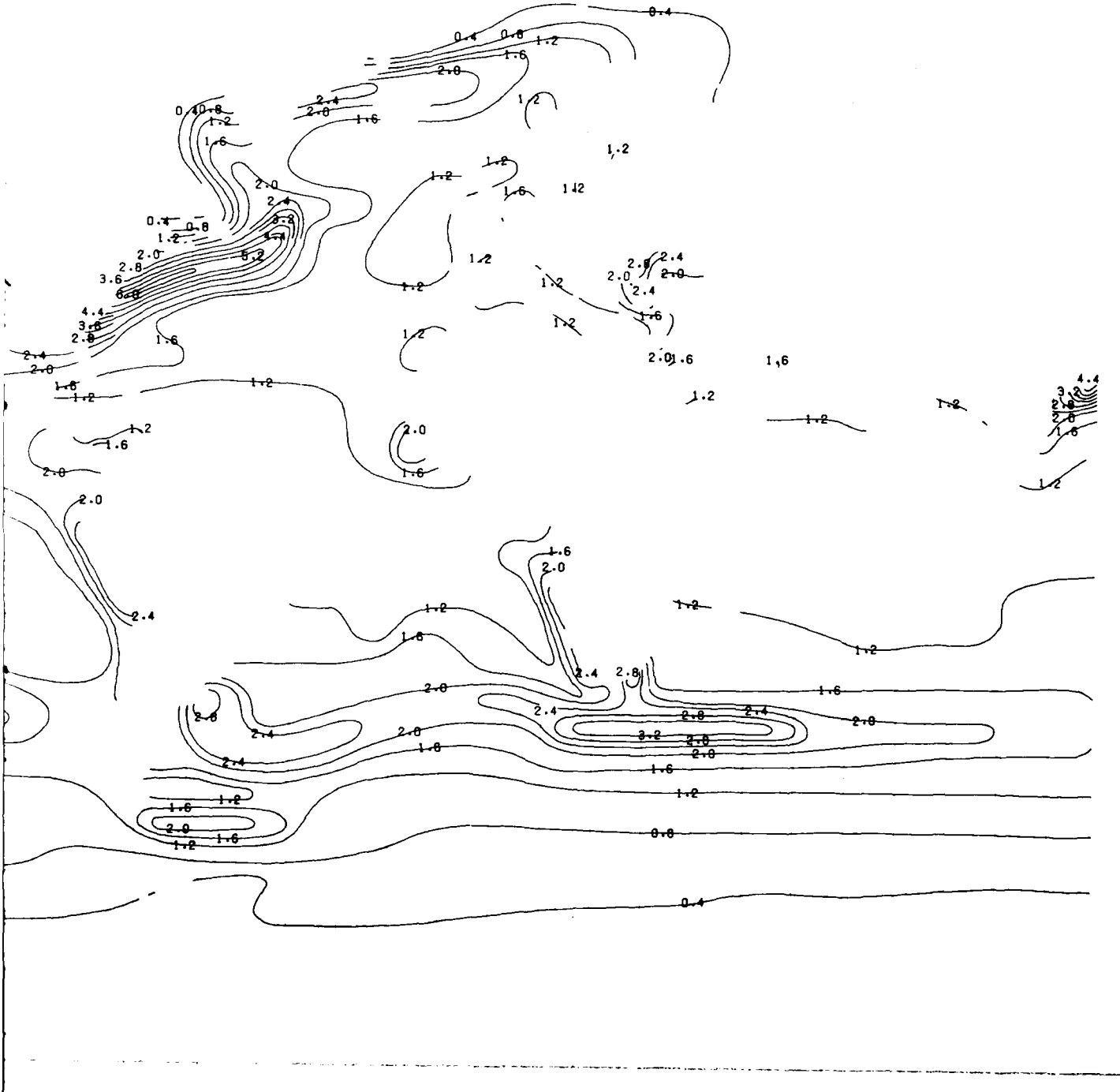


SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



RD DEVIATIONS

MARCH



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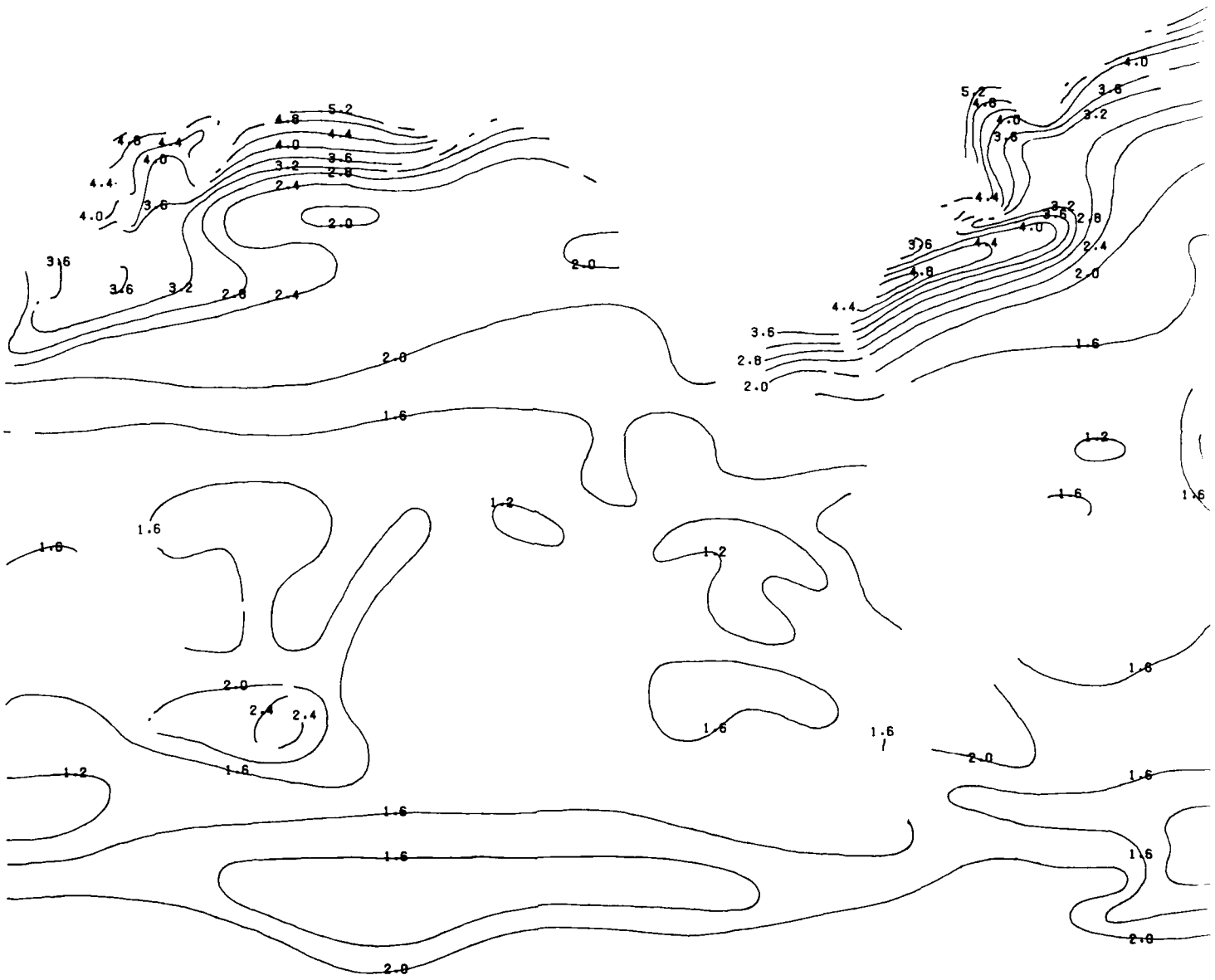
MEAN ICE LIMIT

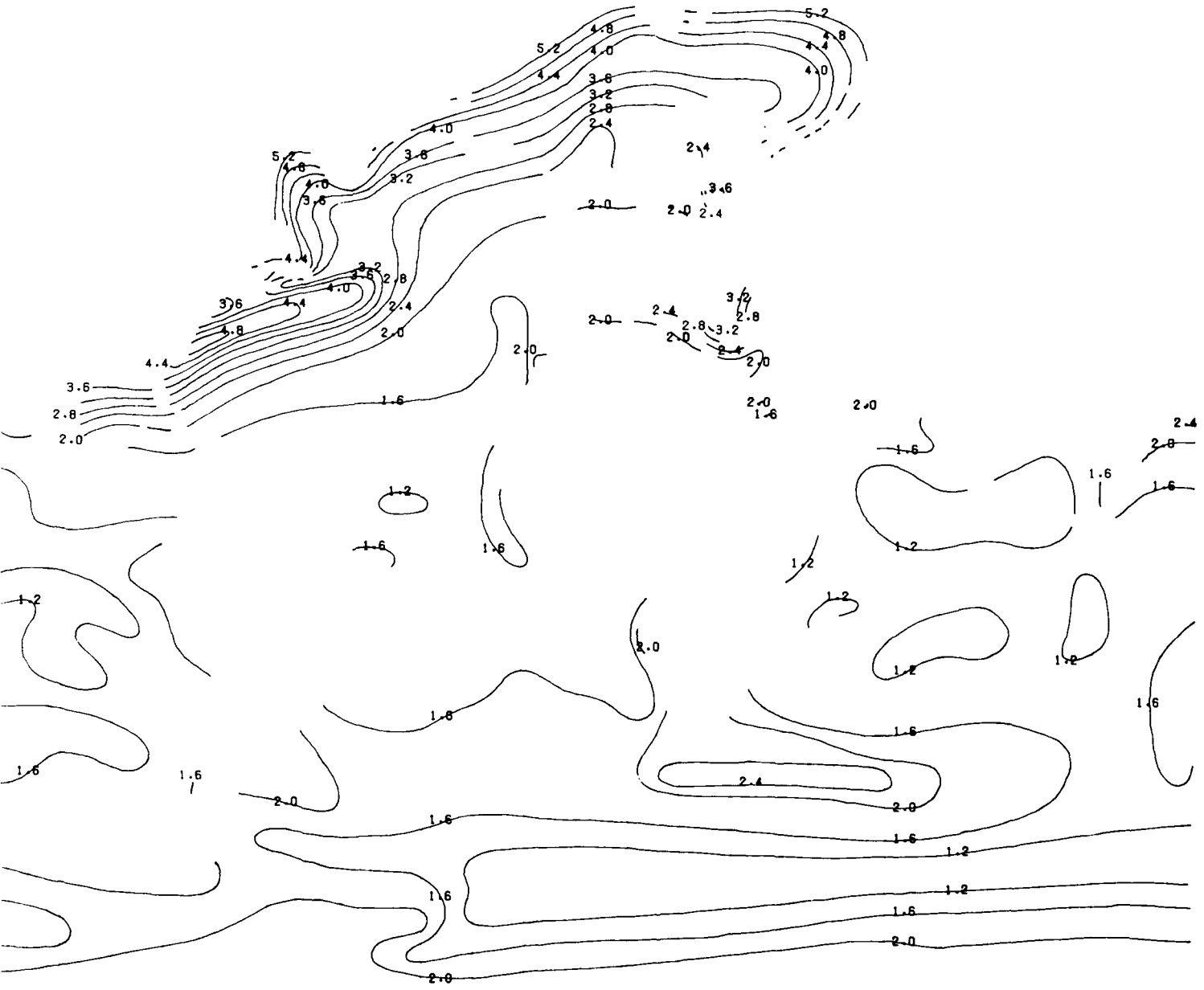
AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIONS



) - STANDARD DEVIATIONS

MARCH



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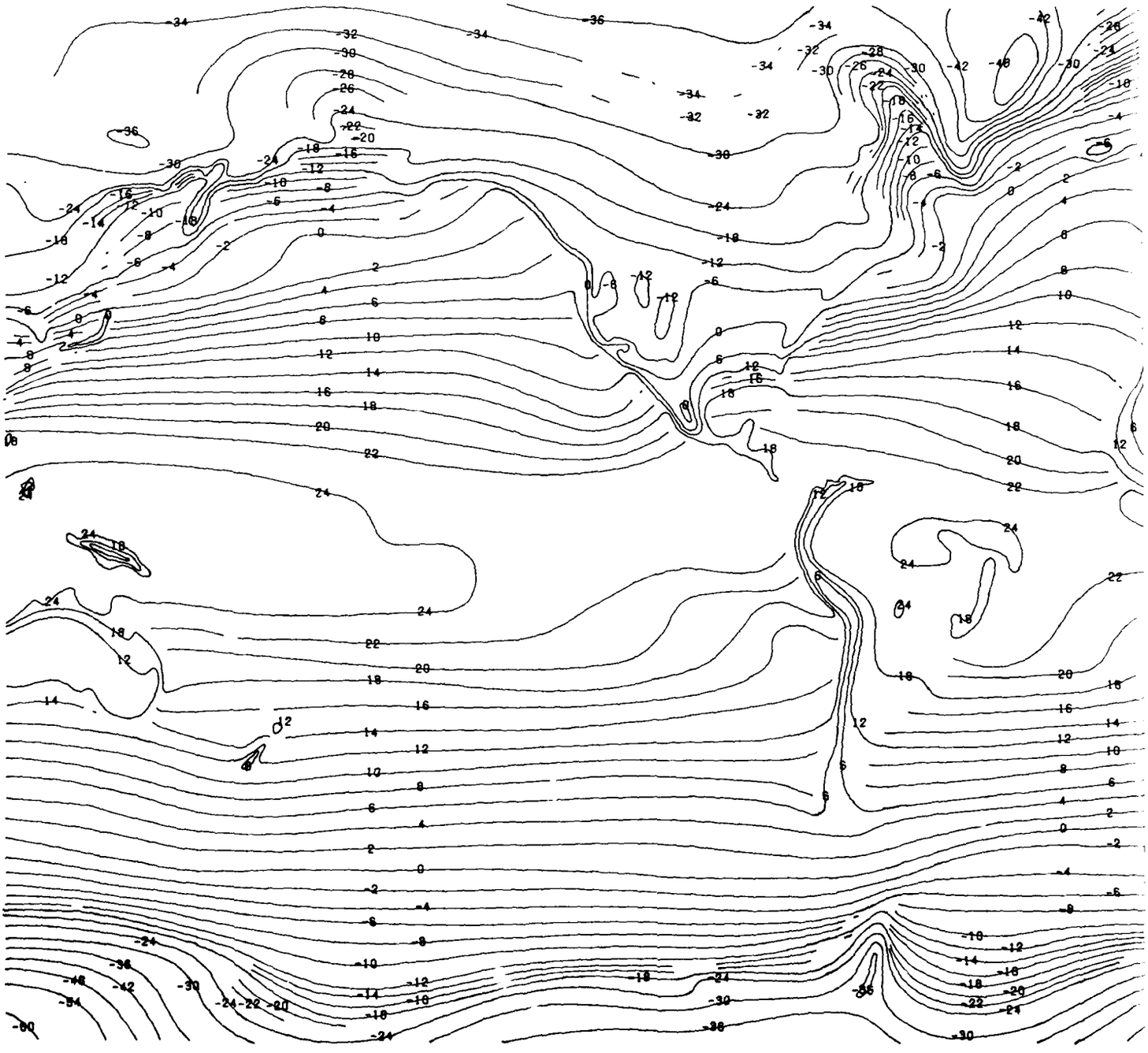
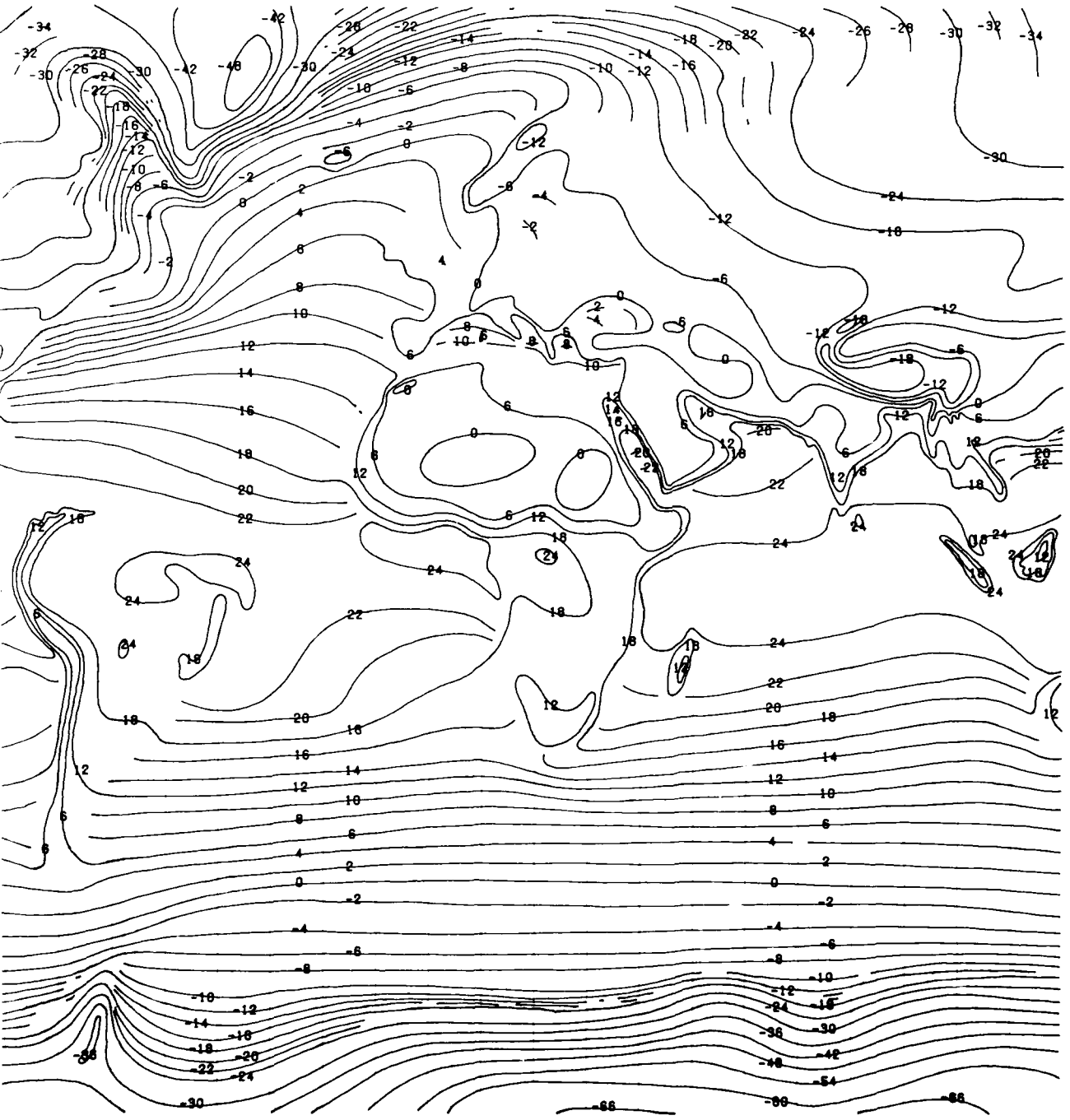
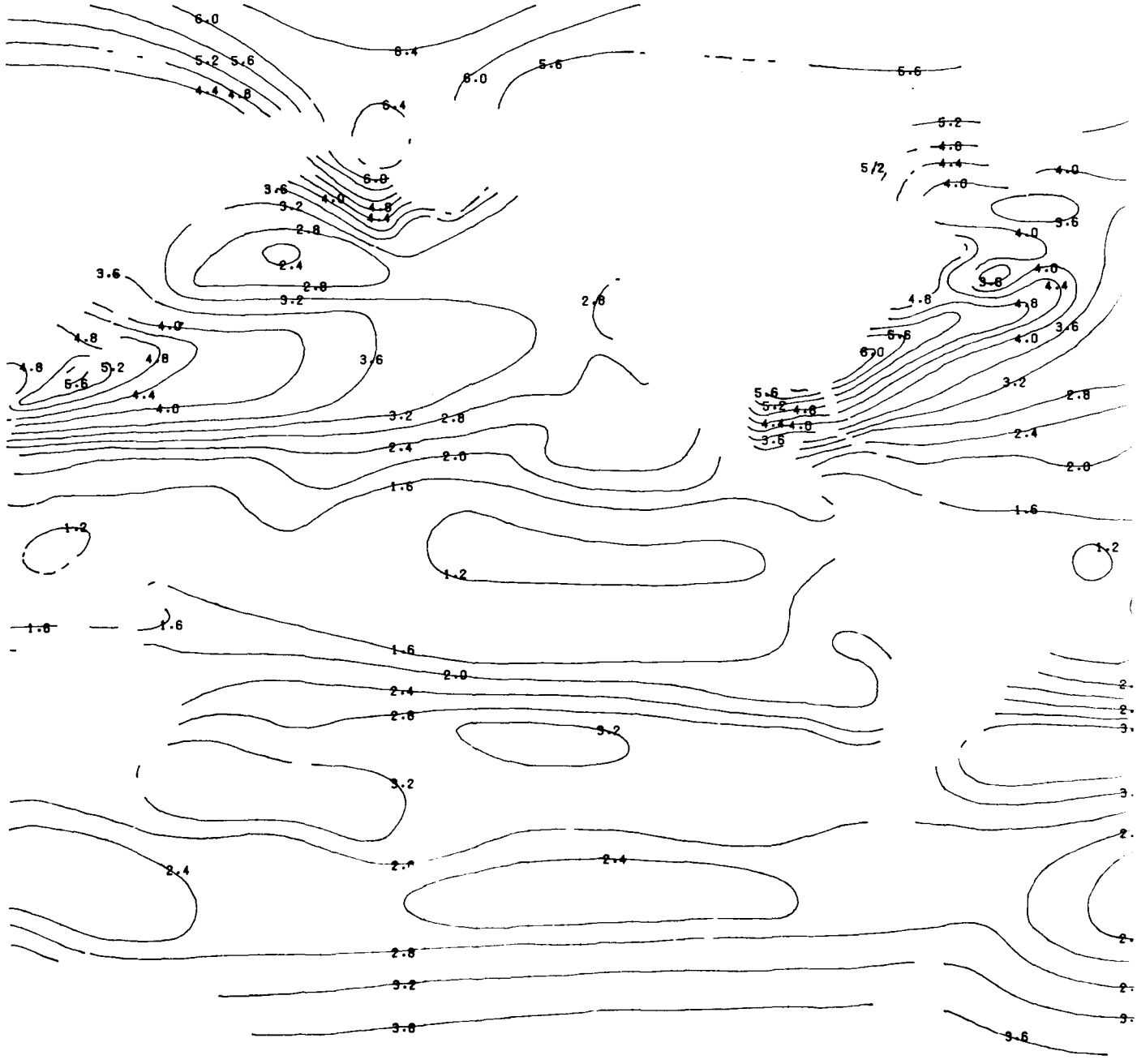


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



D DEVIATIONS

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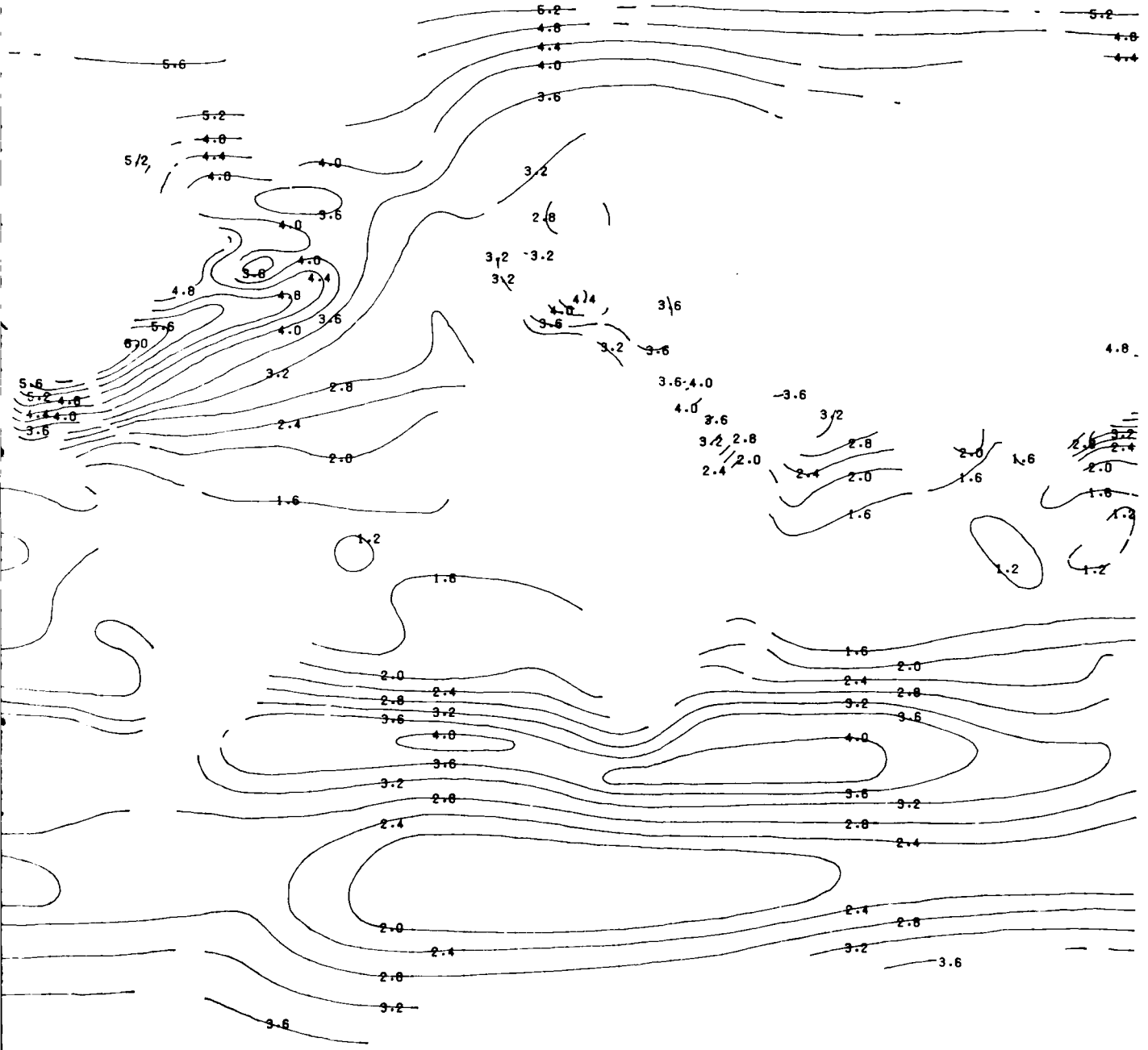

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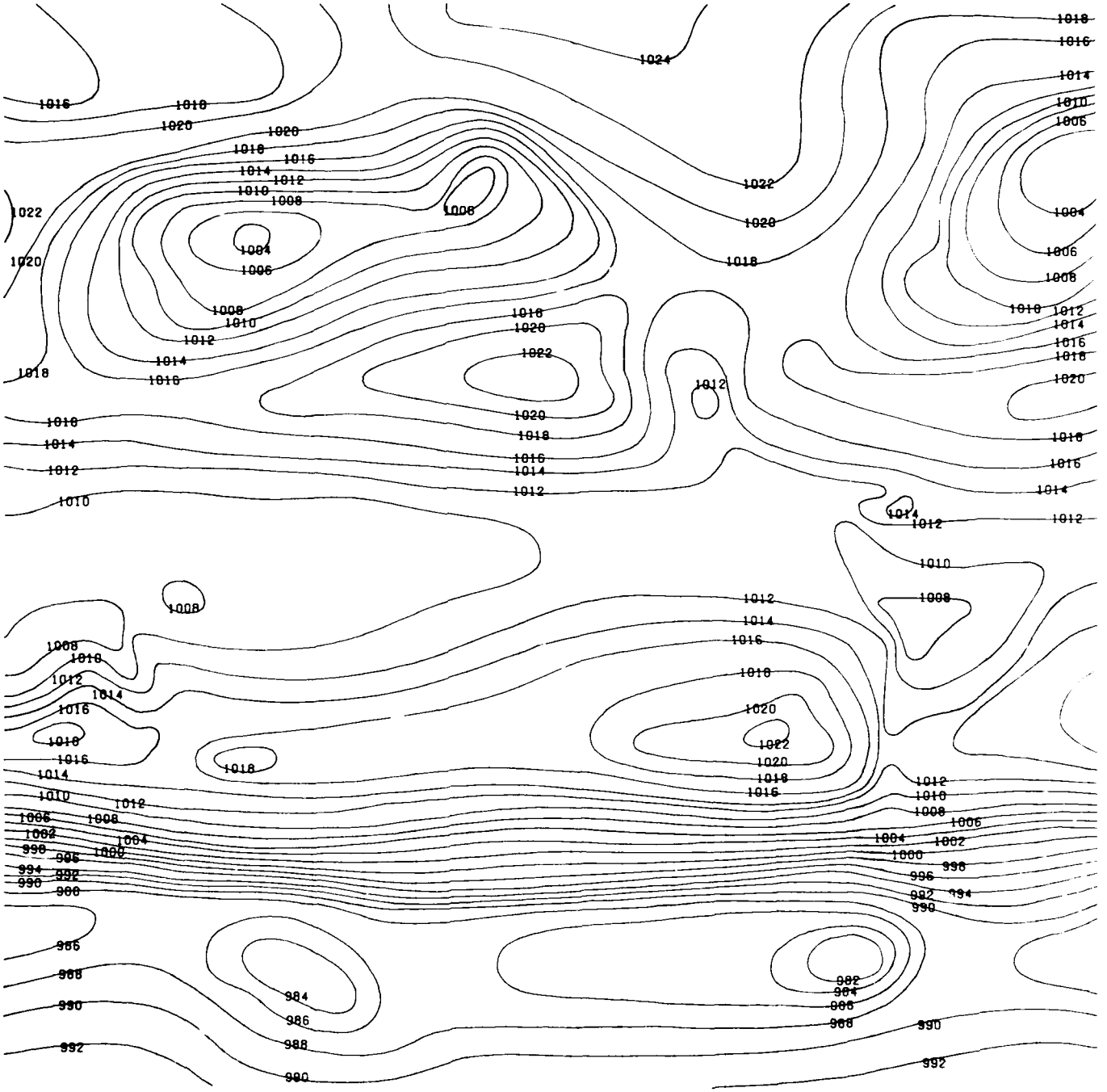
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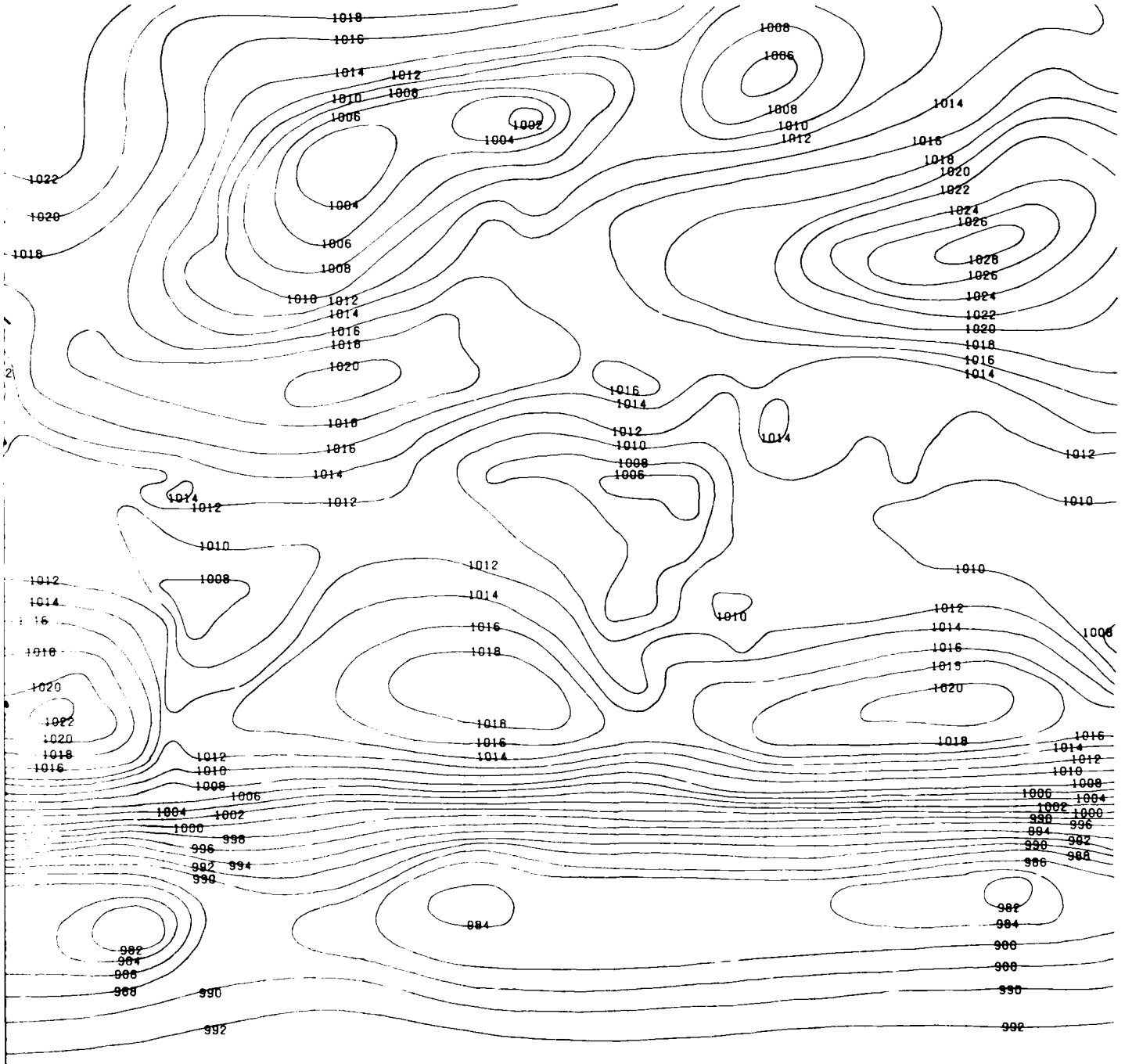
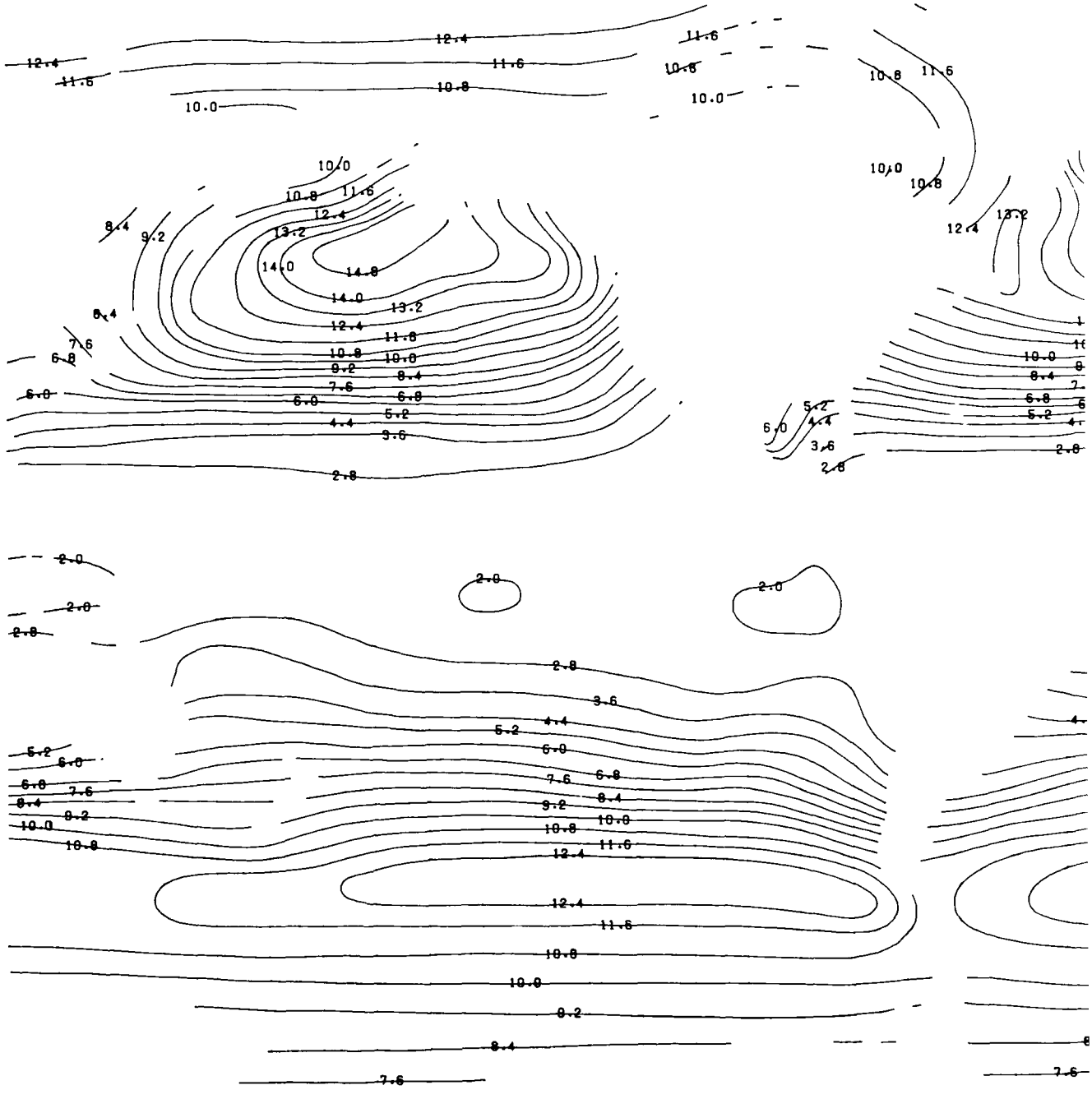
SEA LEVEL PRESSURE (MBS) - MEANS

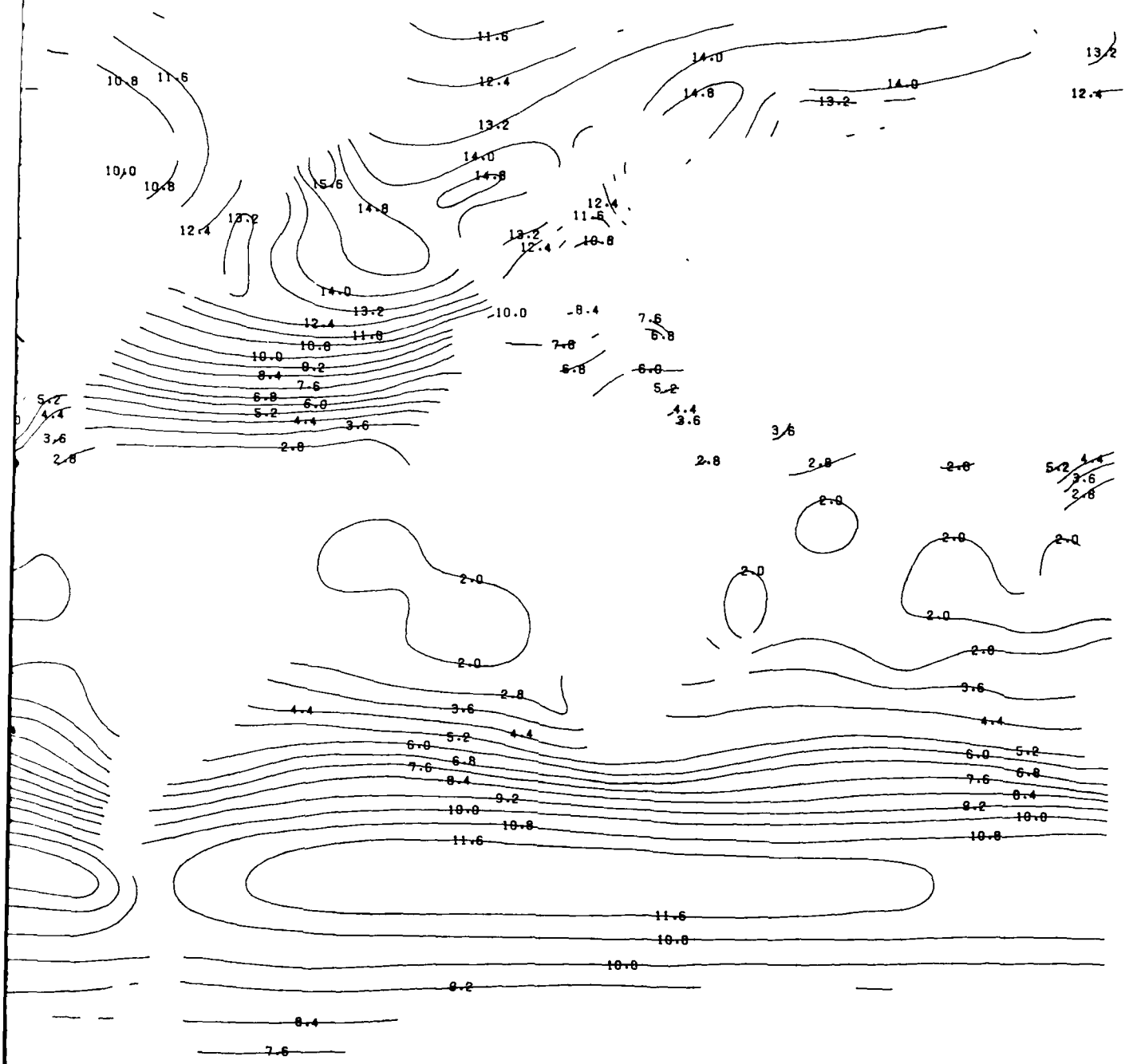


SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



VIATIONS

MARCH



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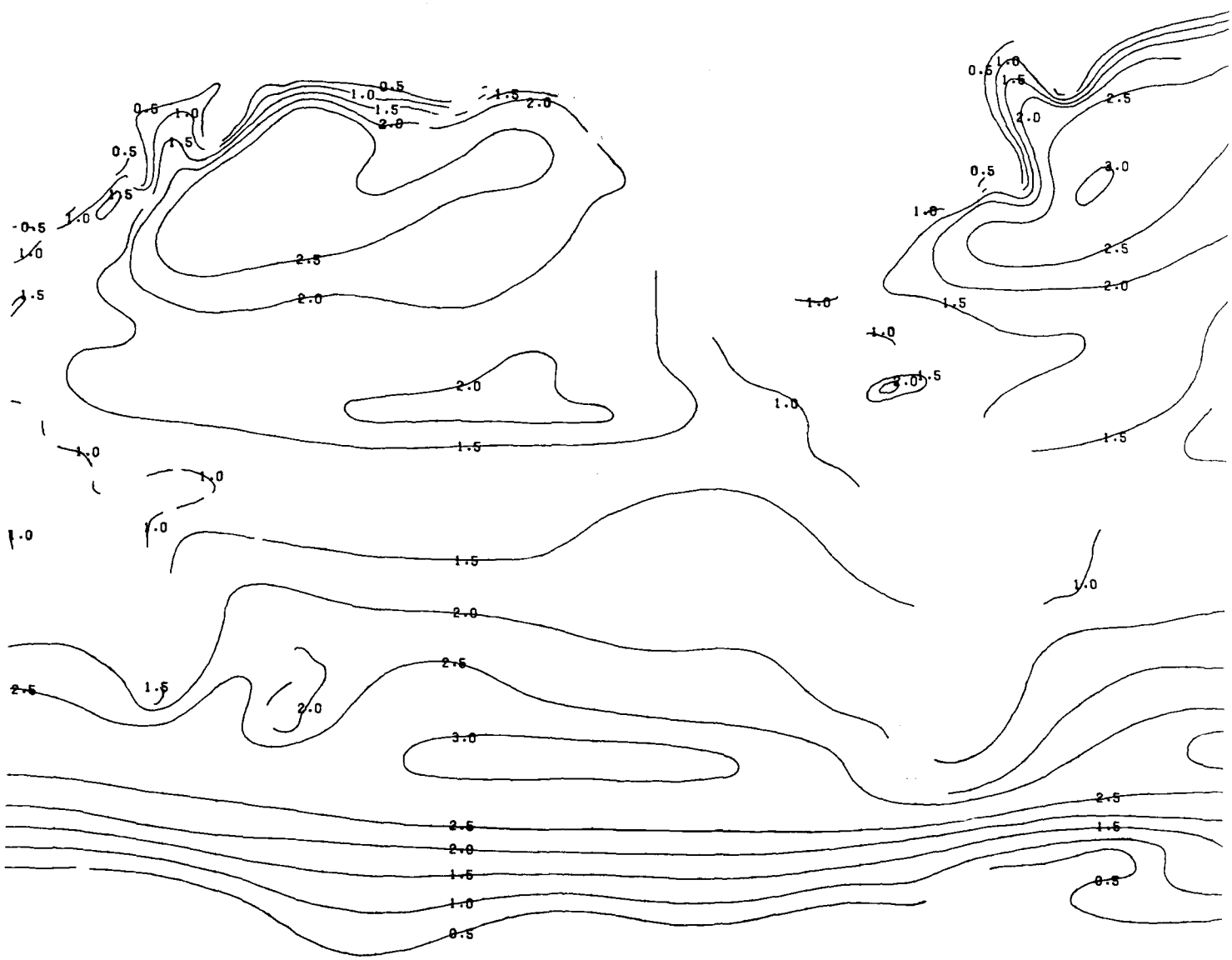
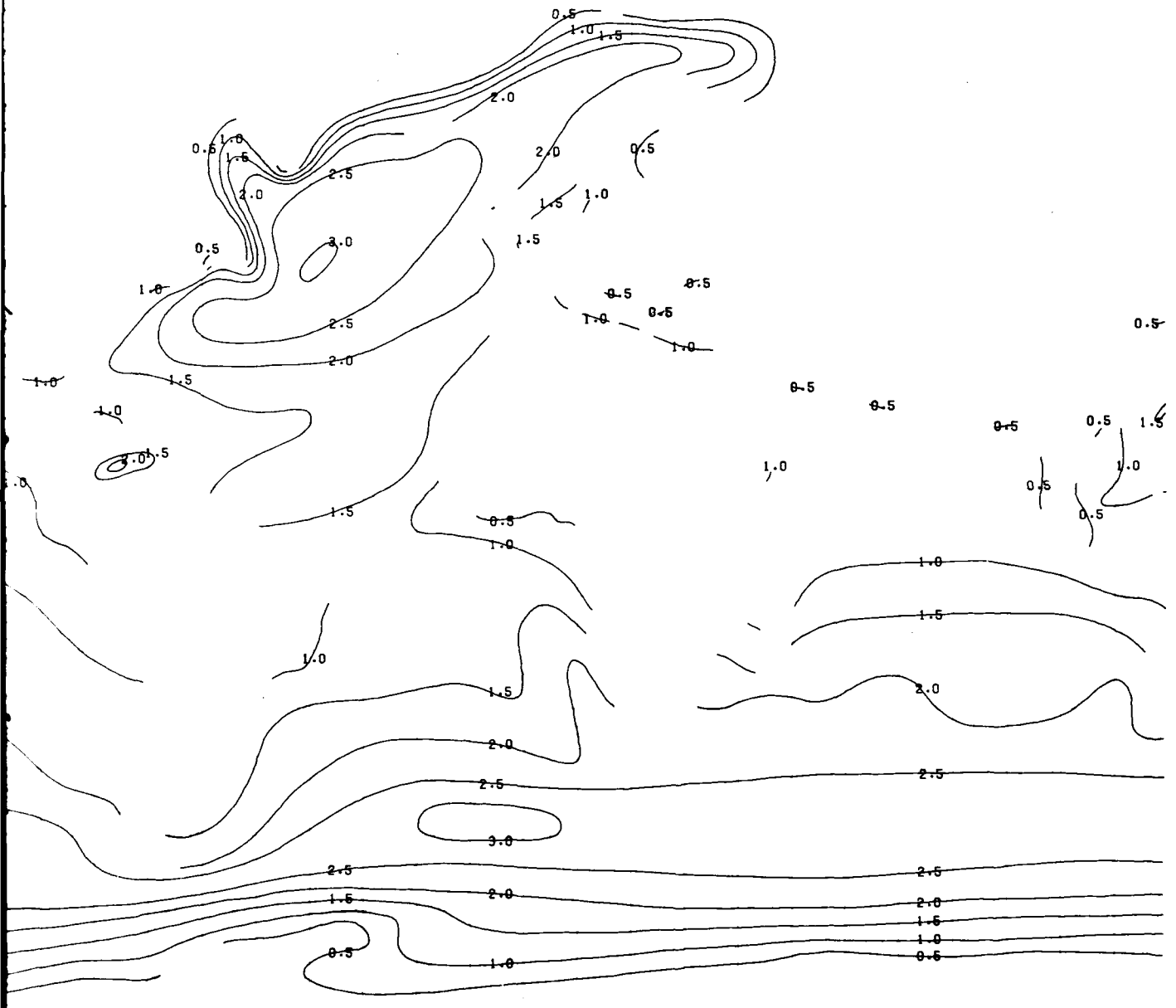
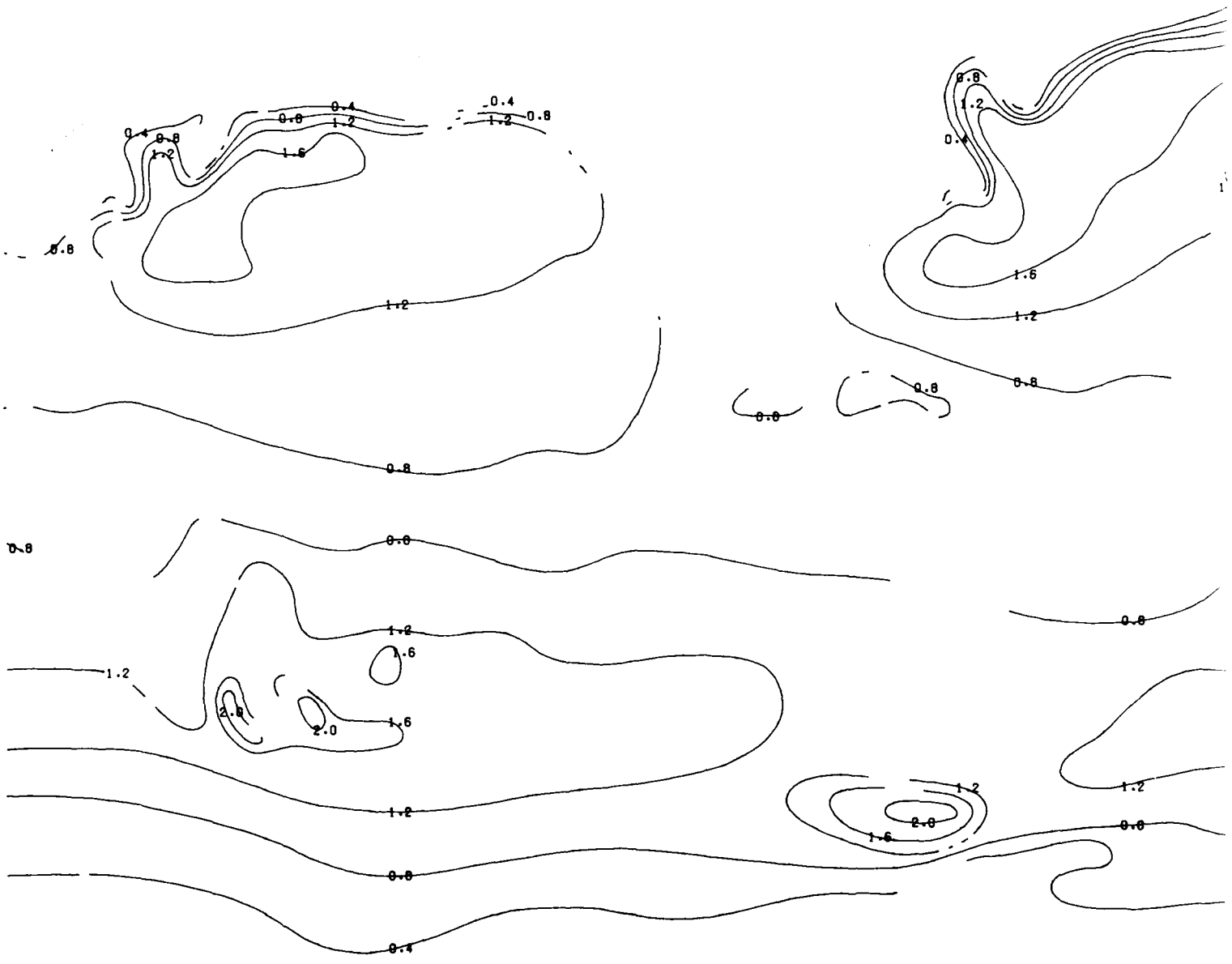
MARCH



WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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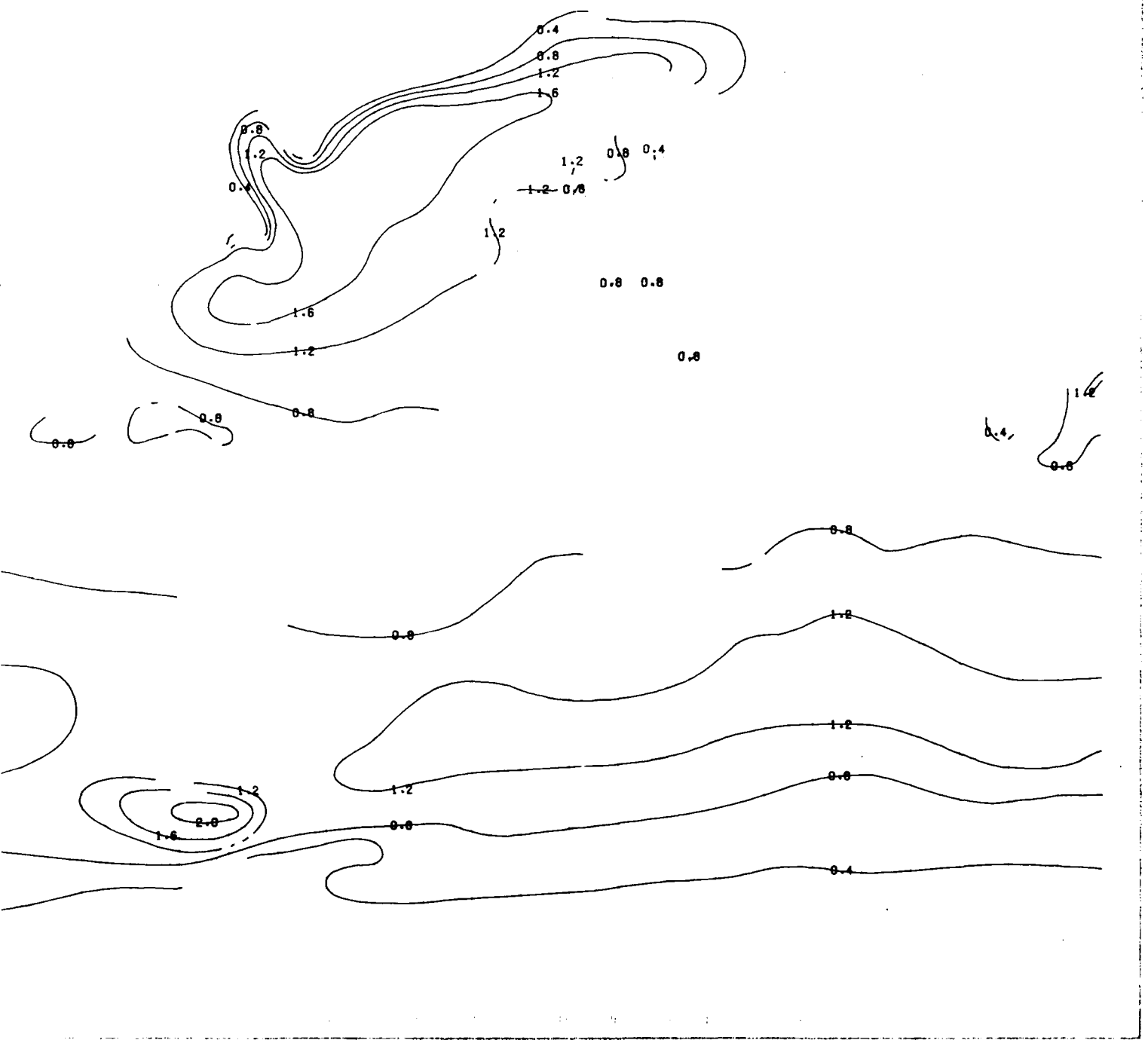

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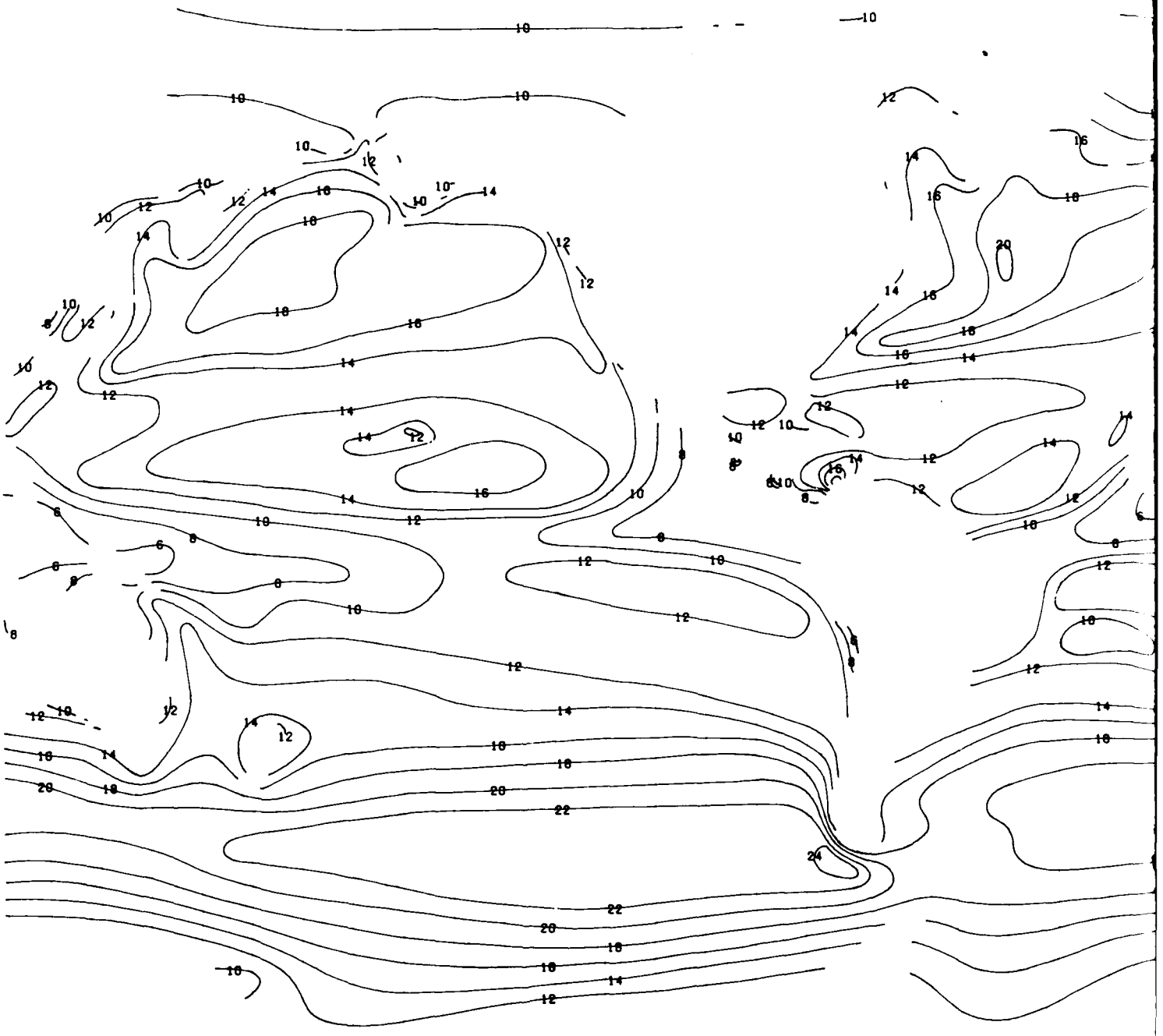
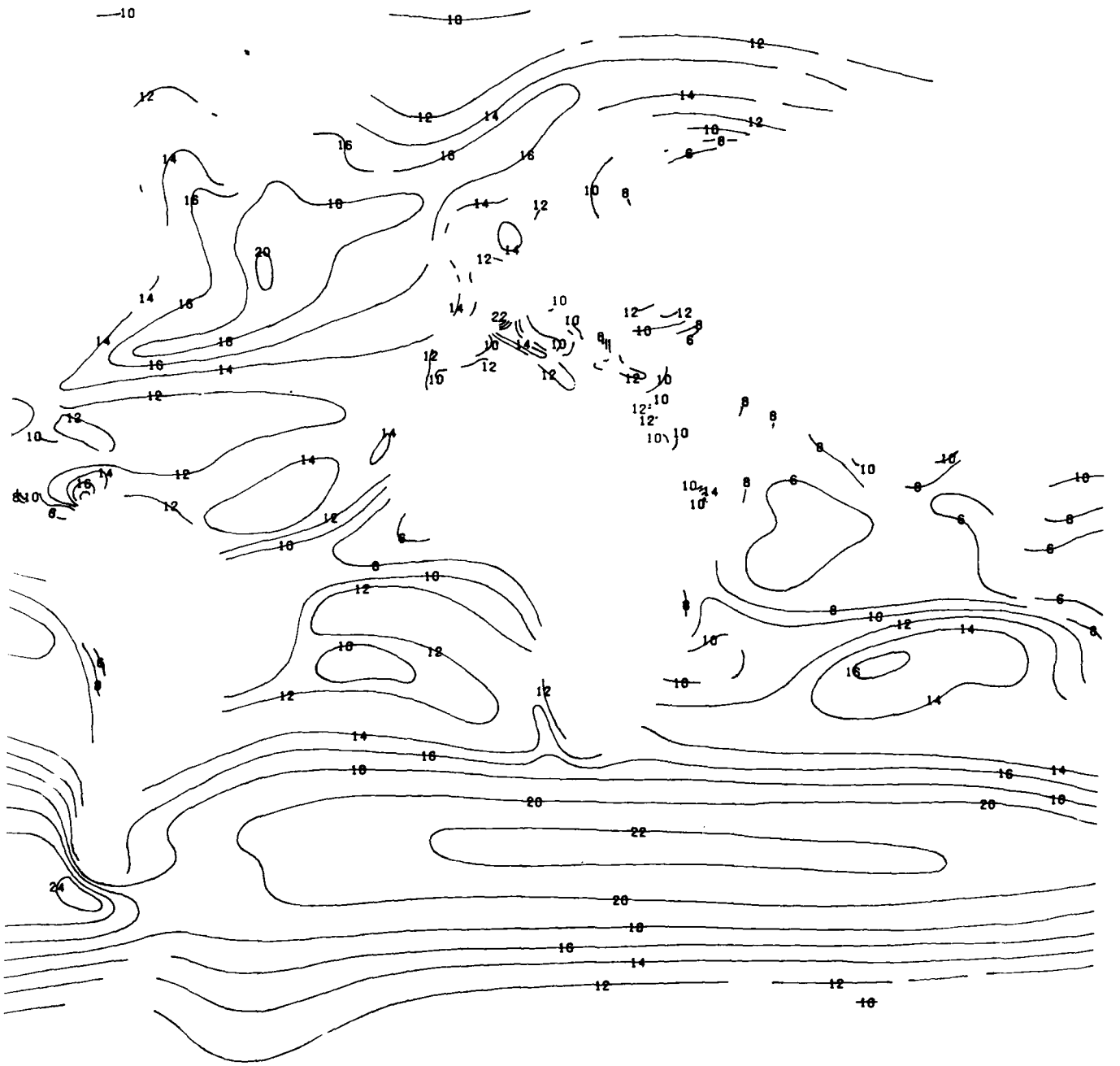
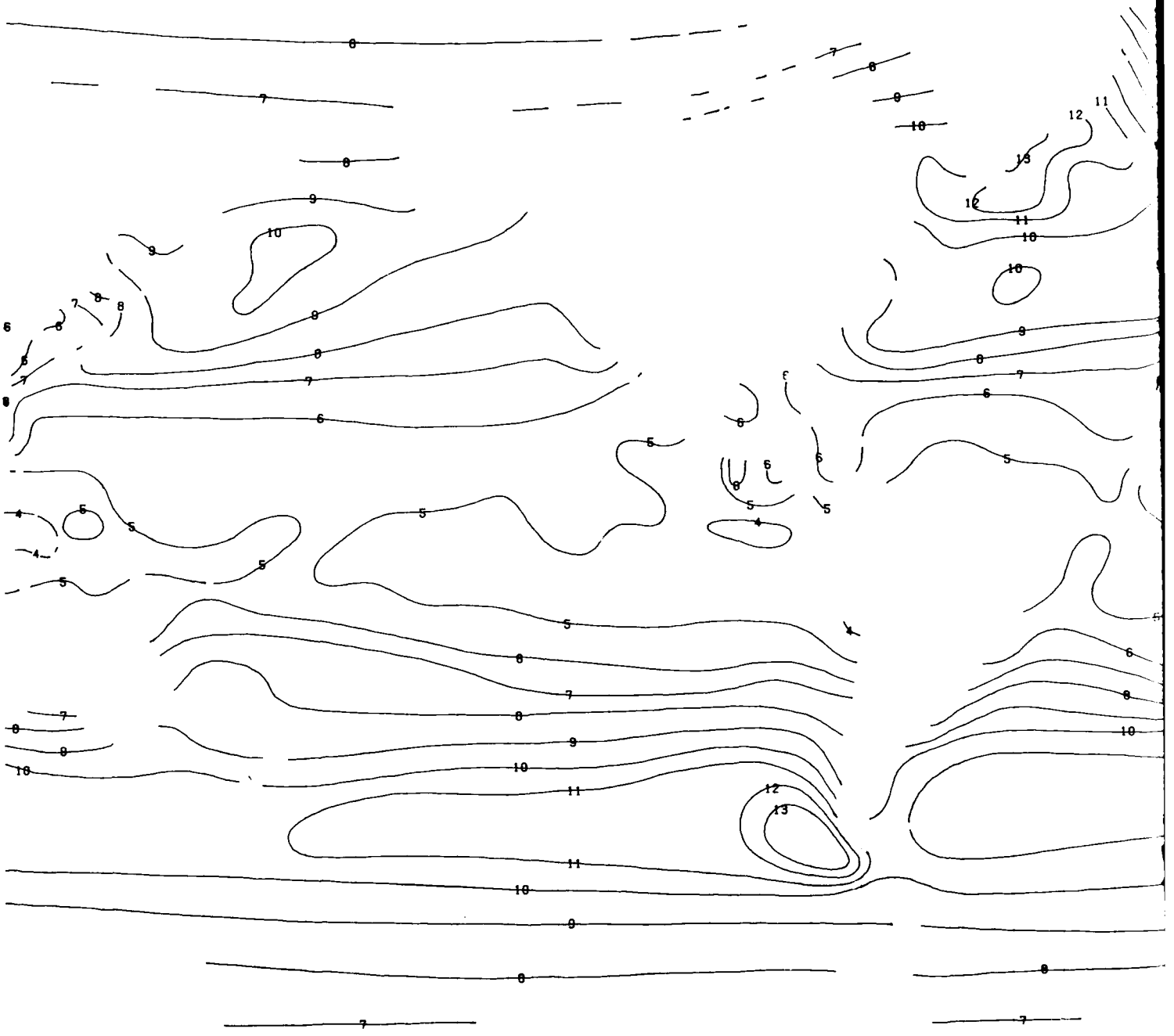
APRIL



SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



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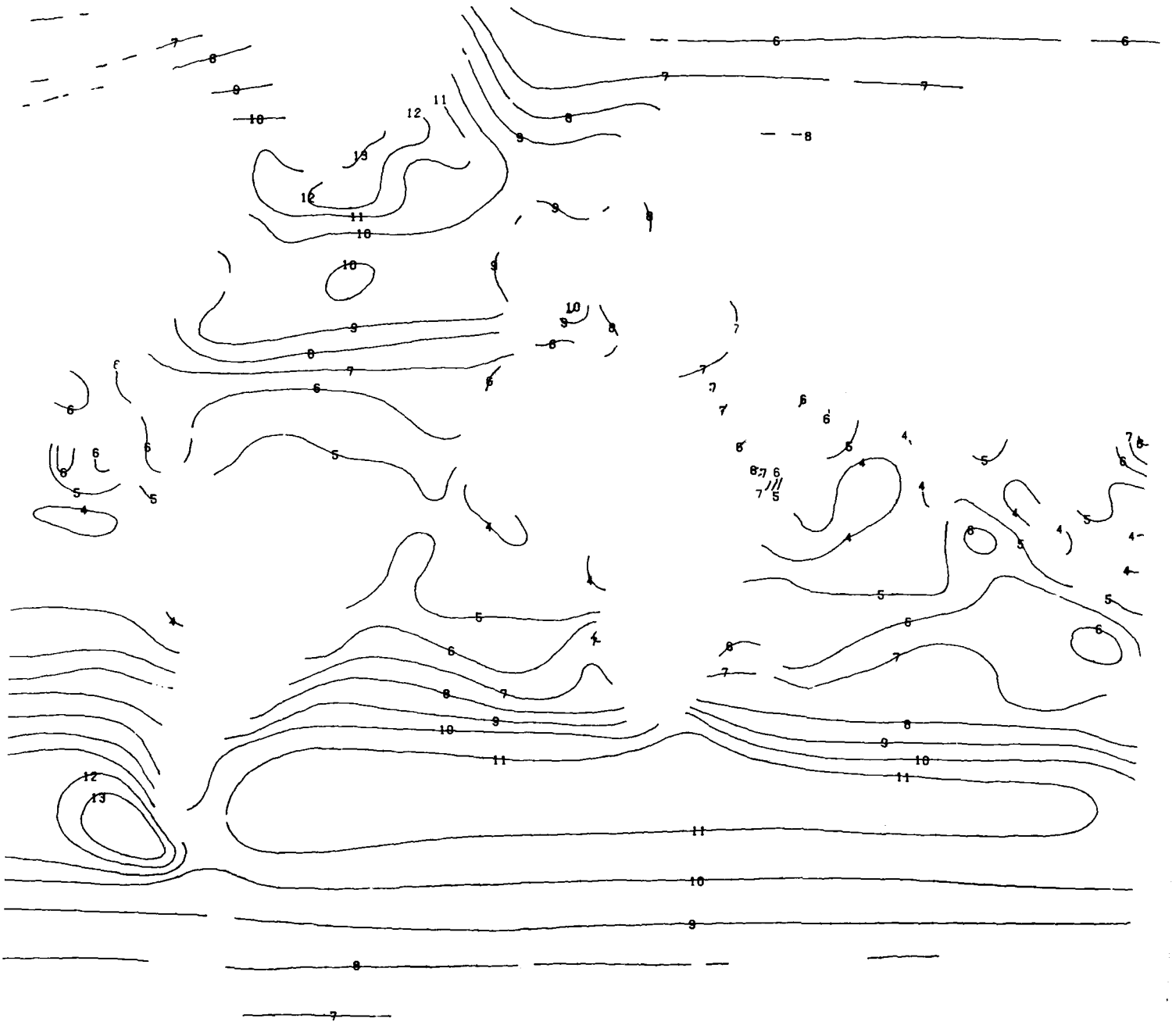

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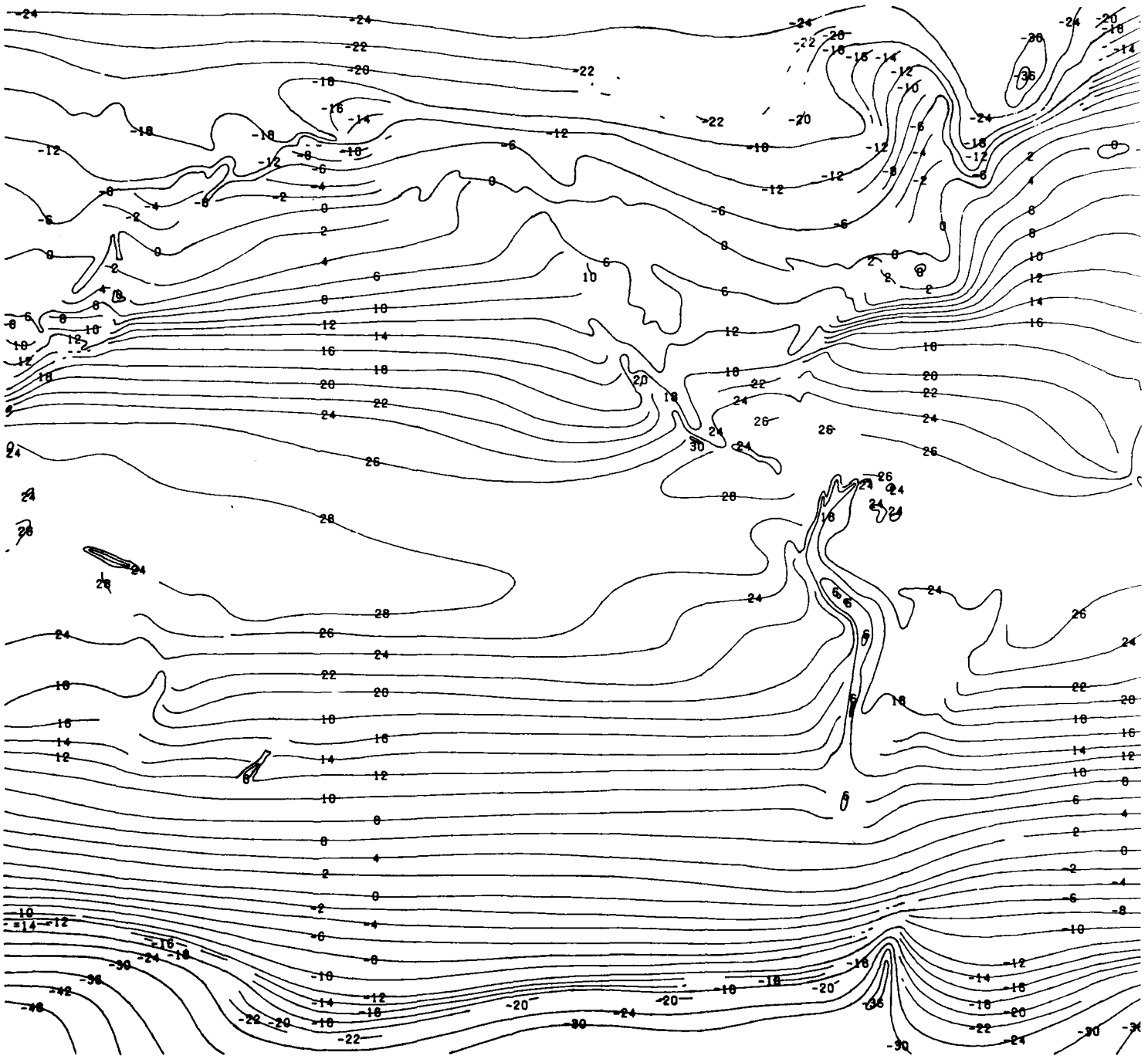
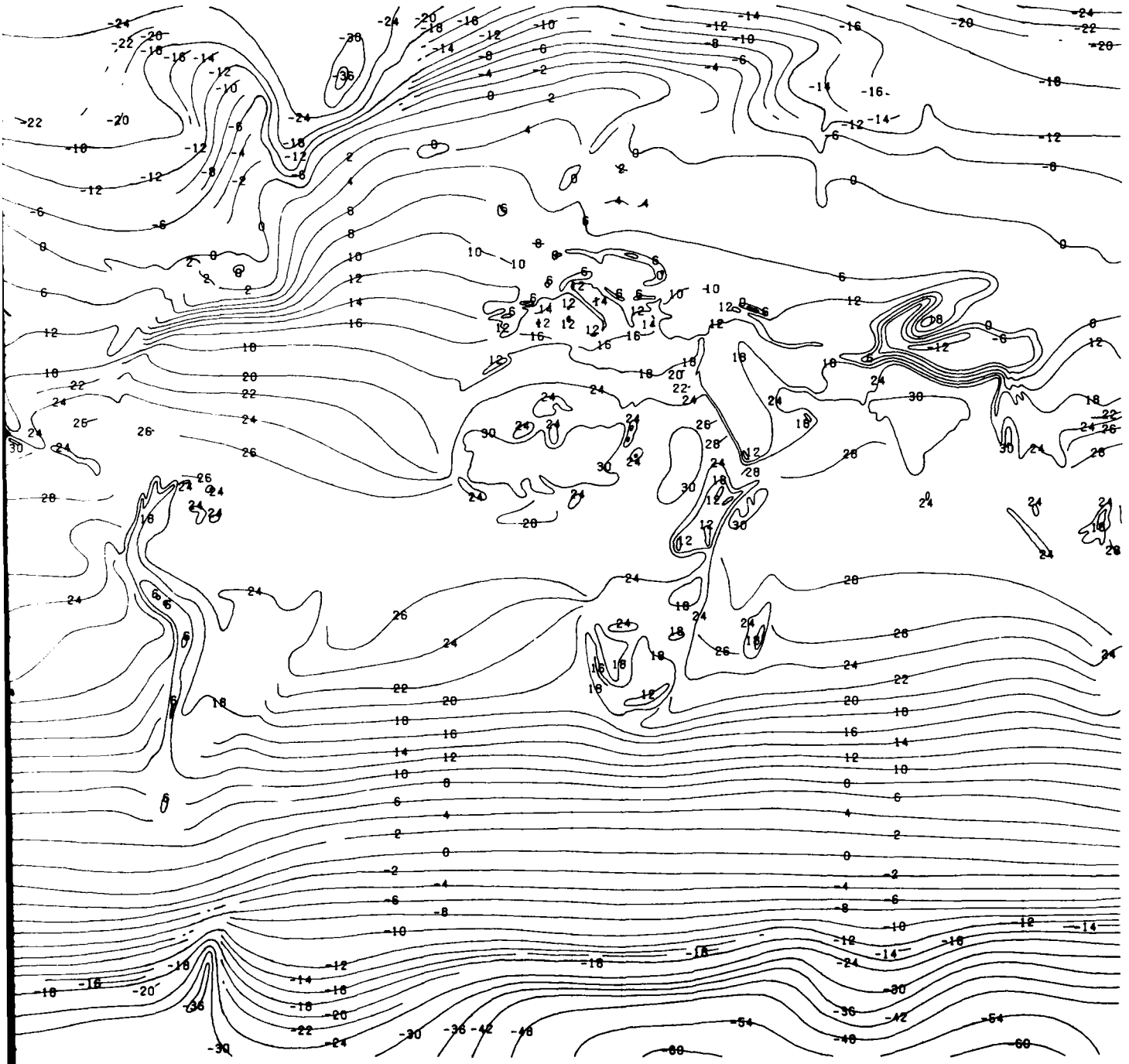
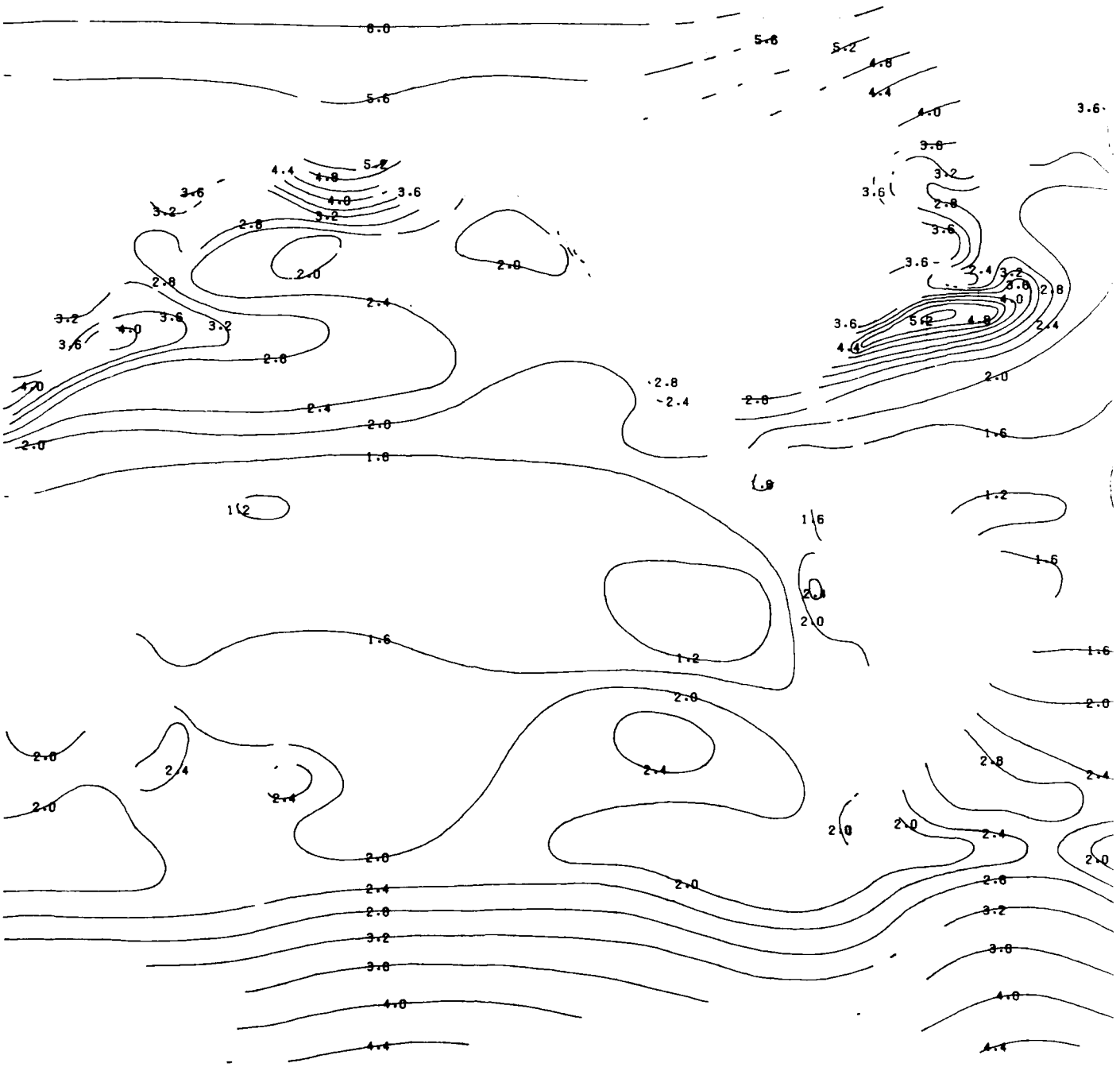


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



DARD DEVIATIONS

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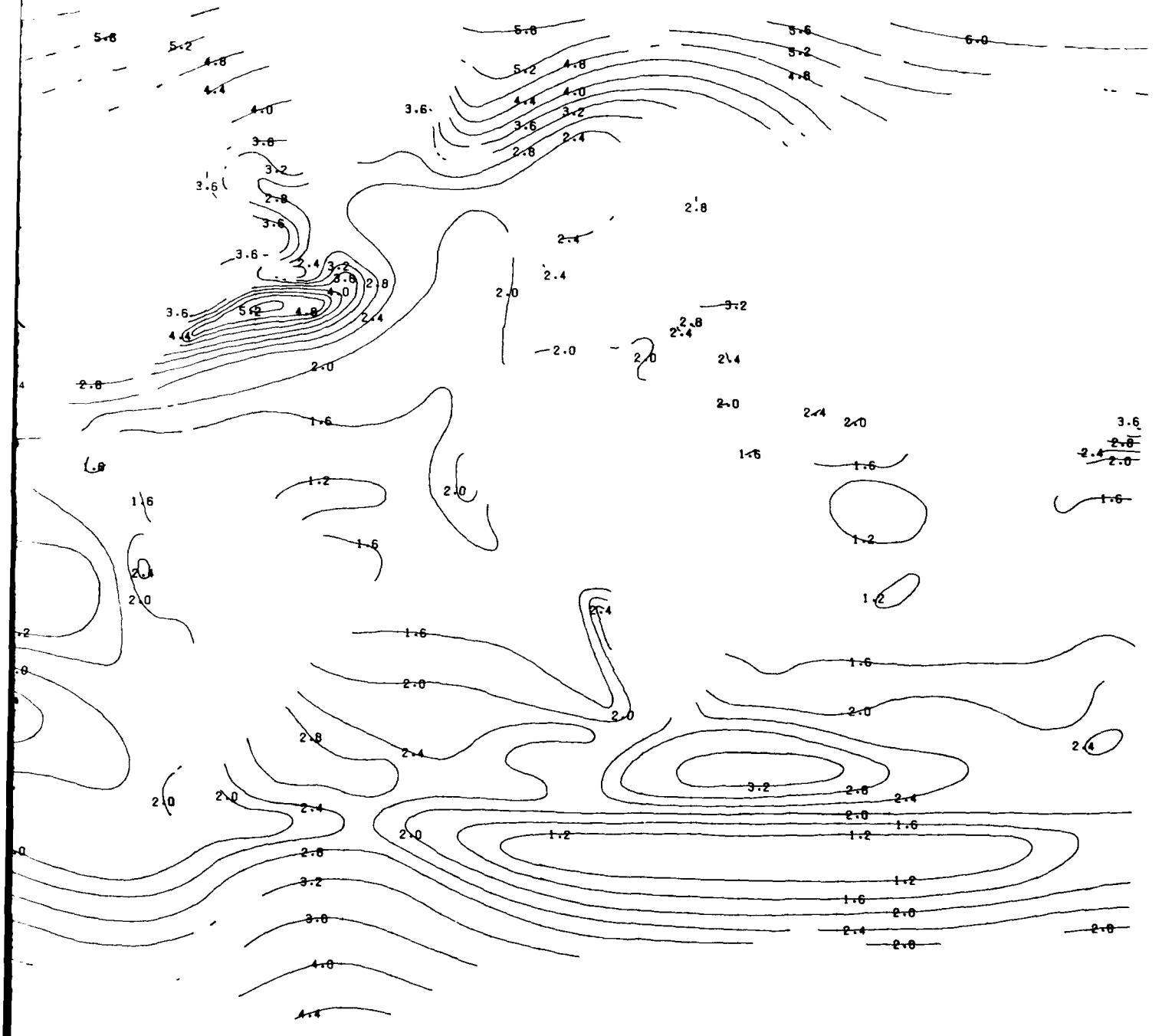

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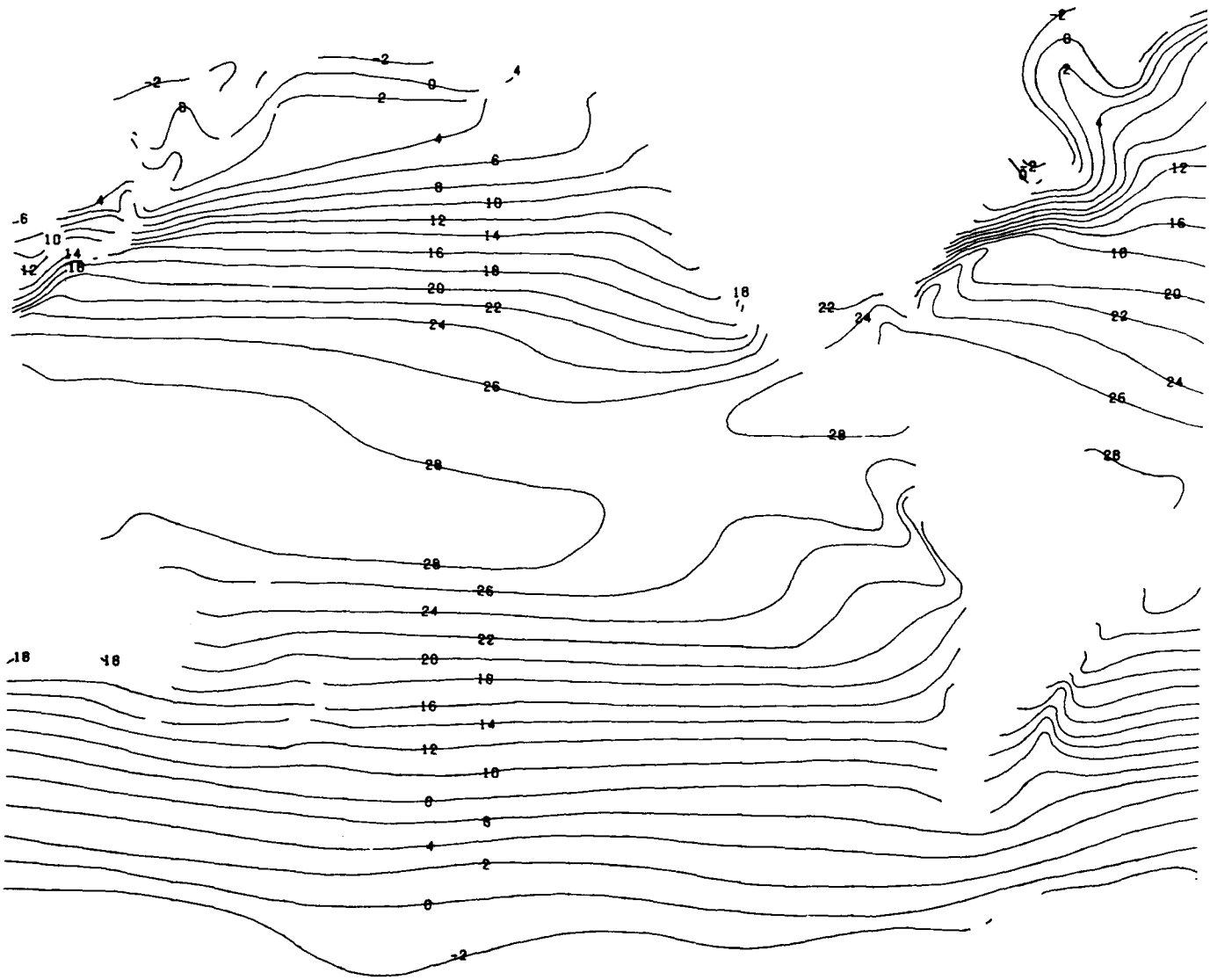
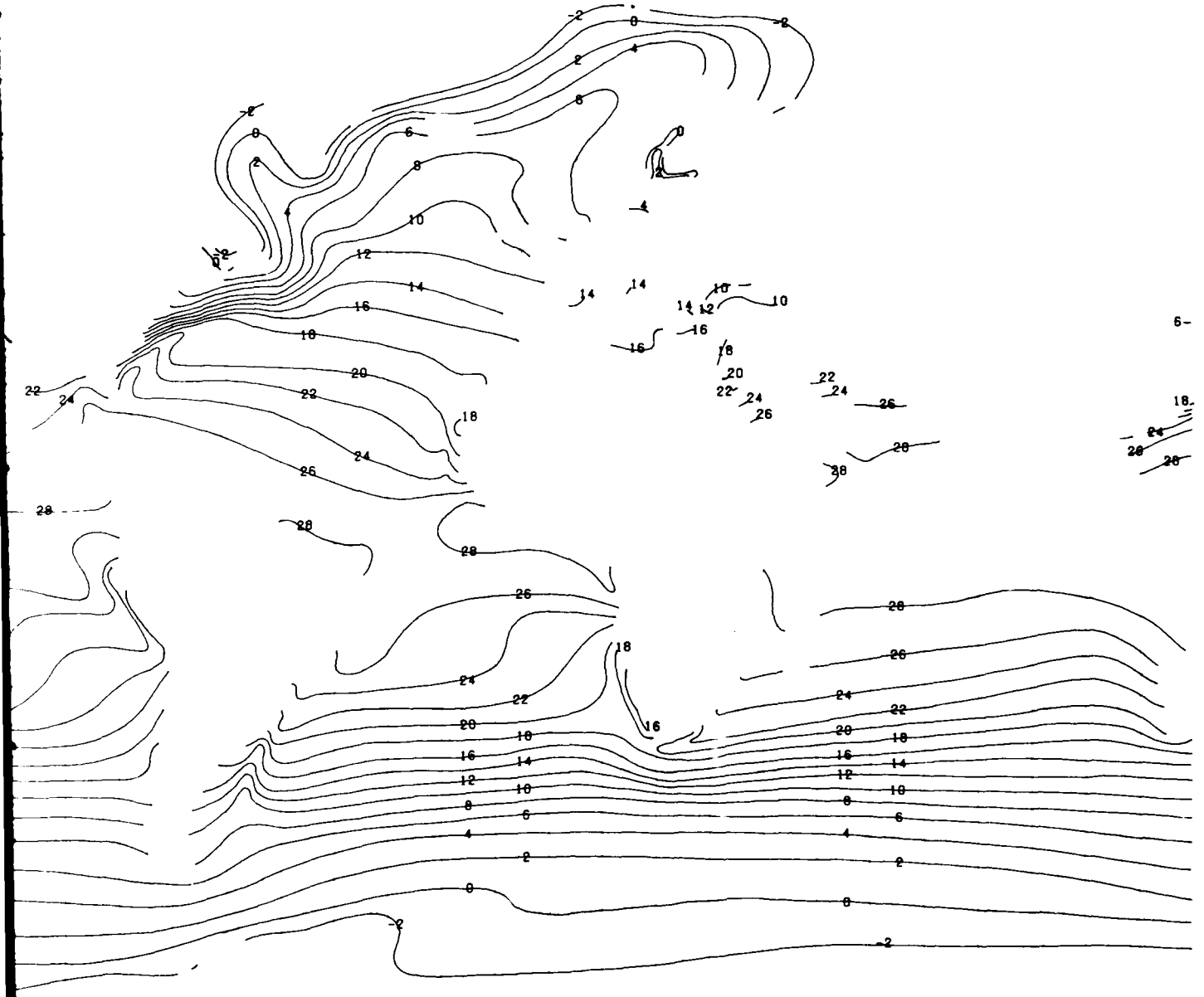
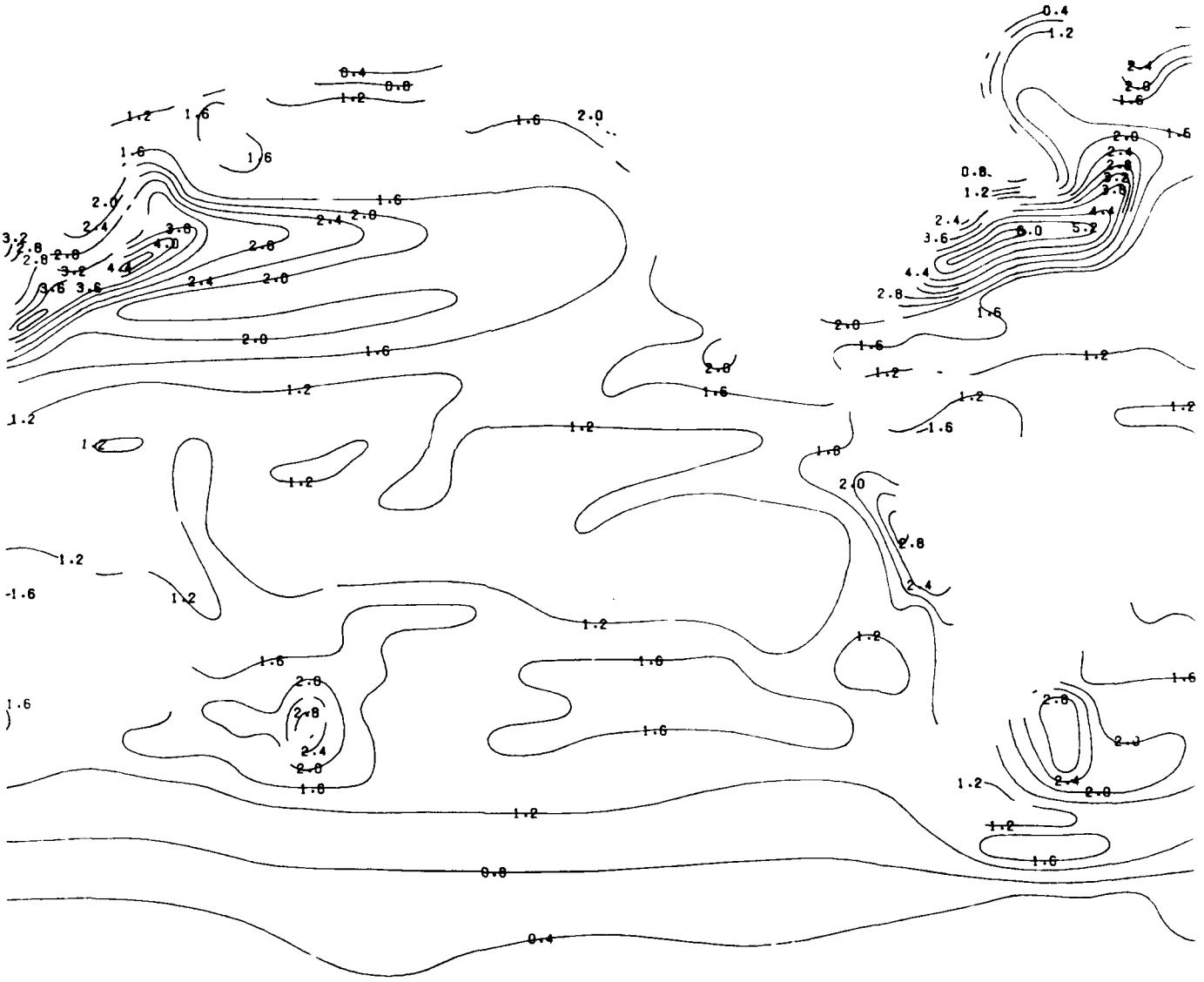


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



ARD DEVIATIONS

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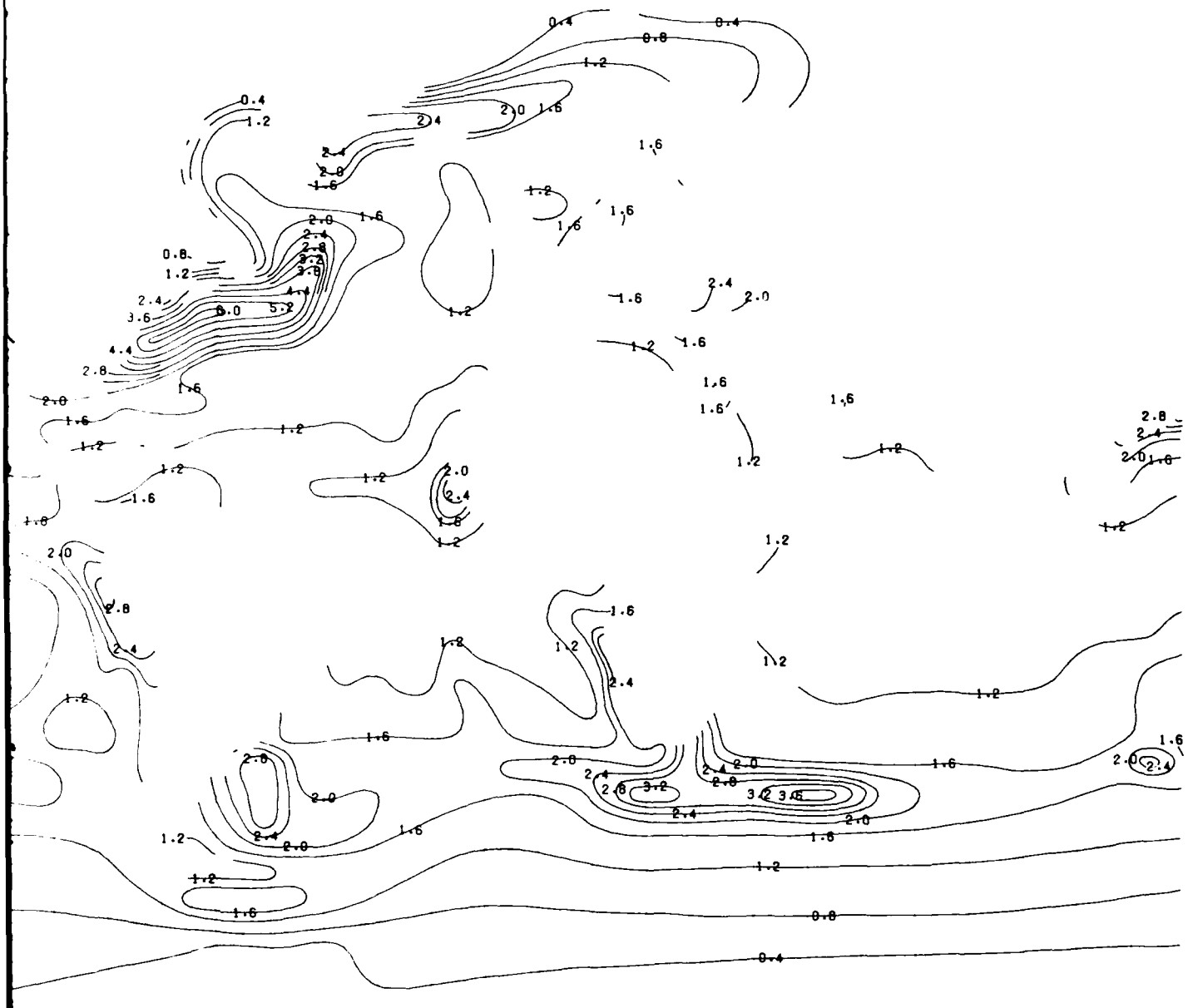
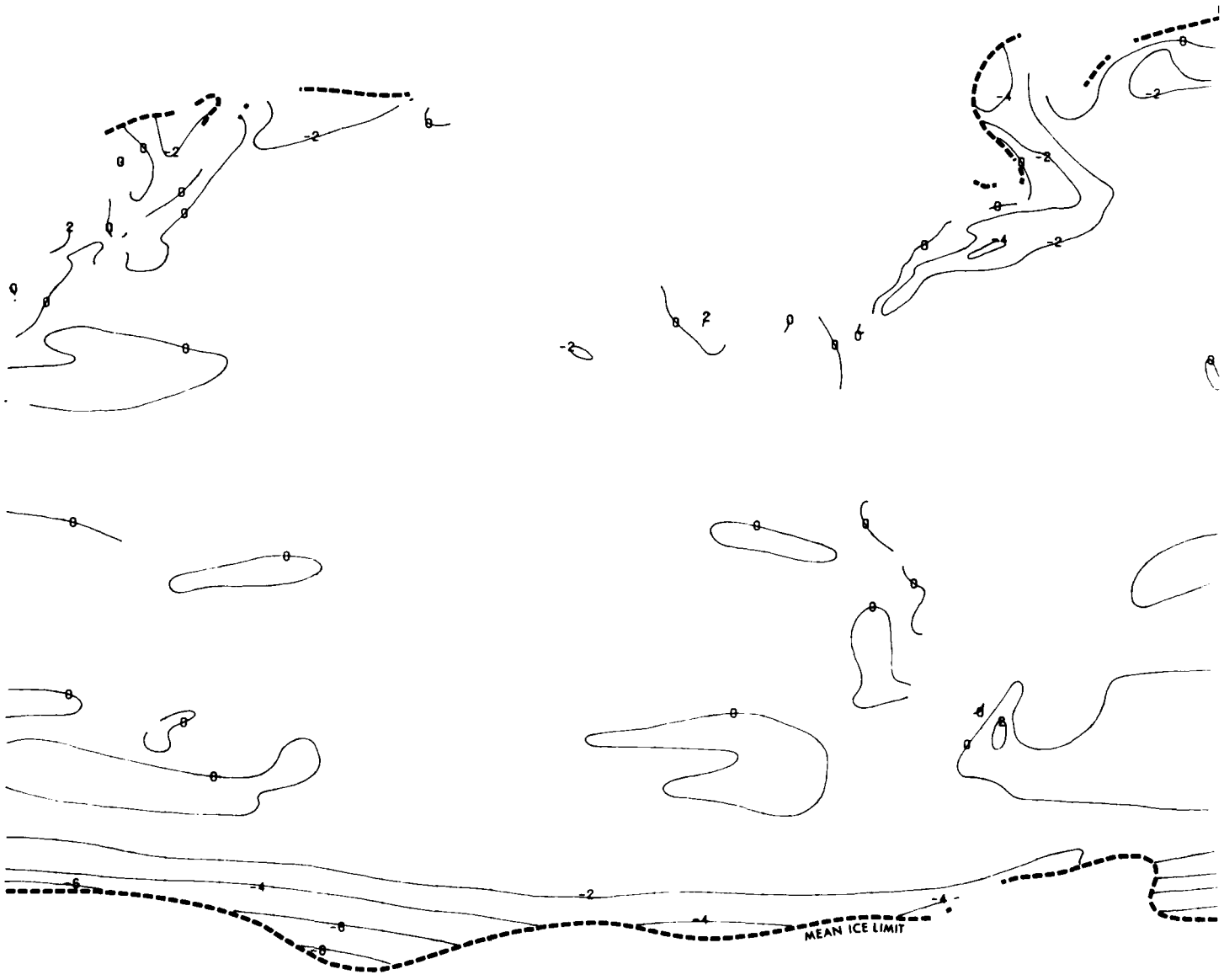
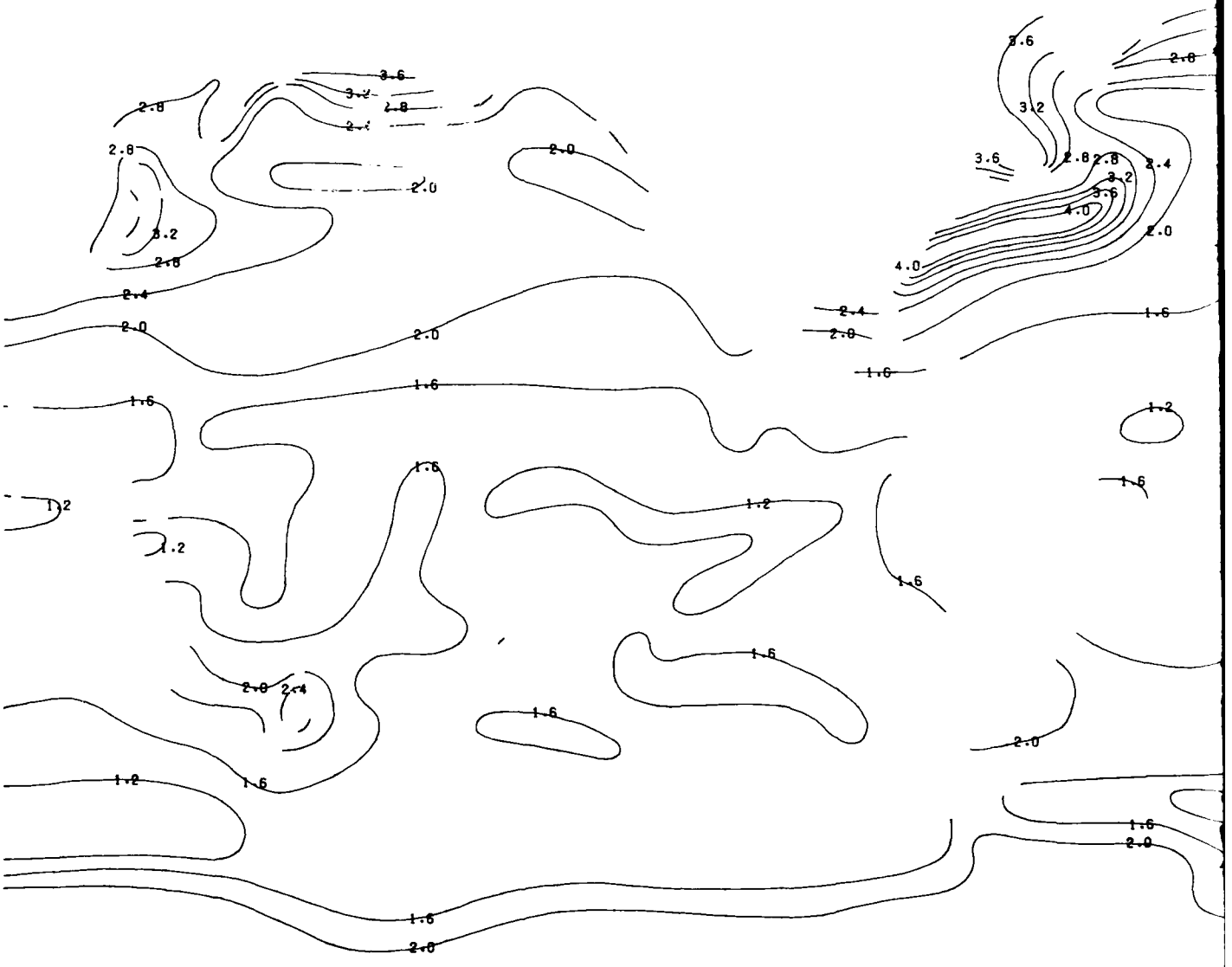



MEAN ICE LIMIT

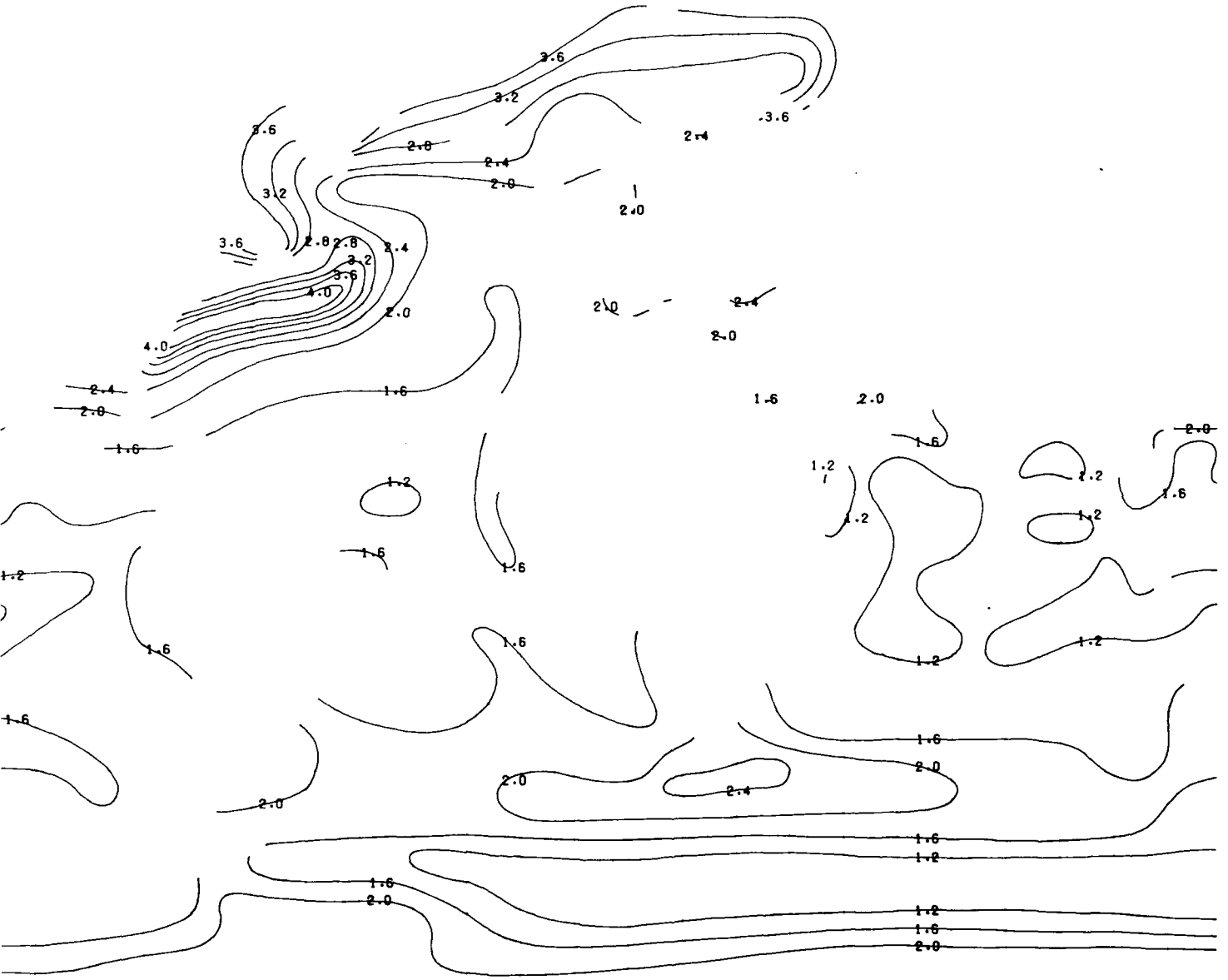
AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIONS



- STANDARD DEVIATIONS

APRIL



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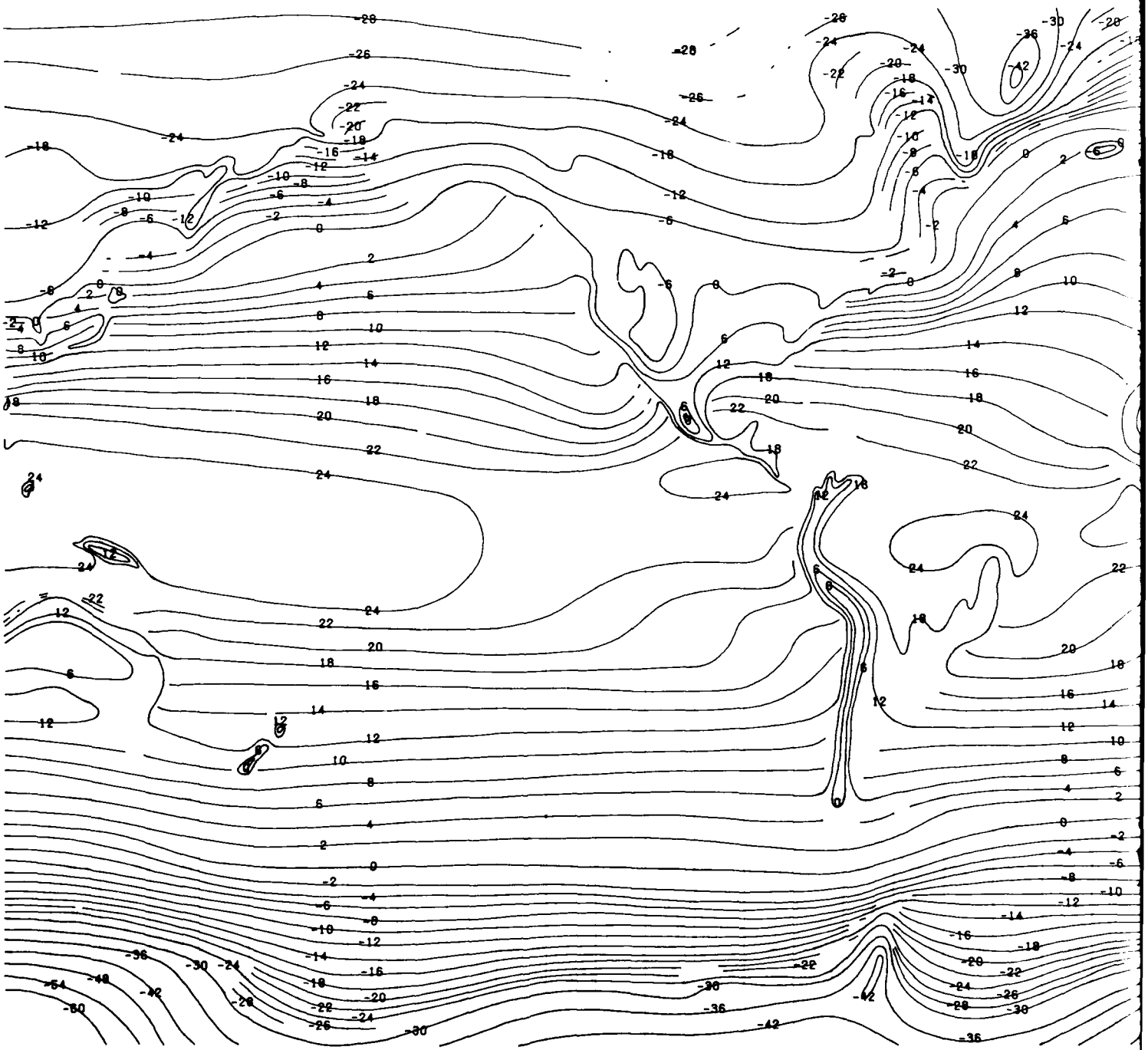
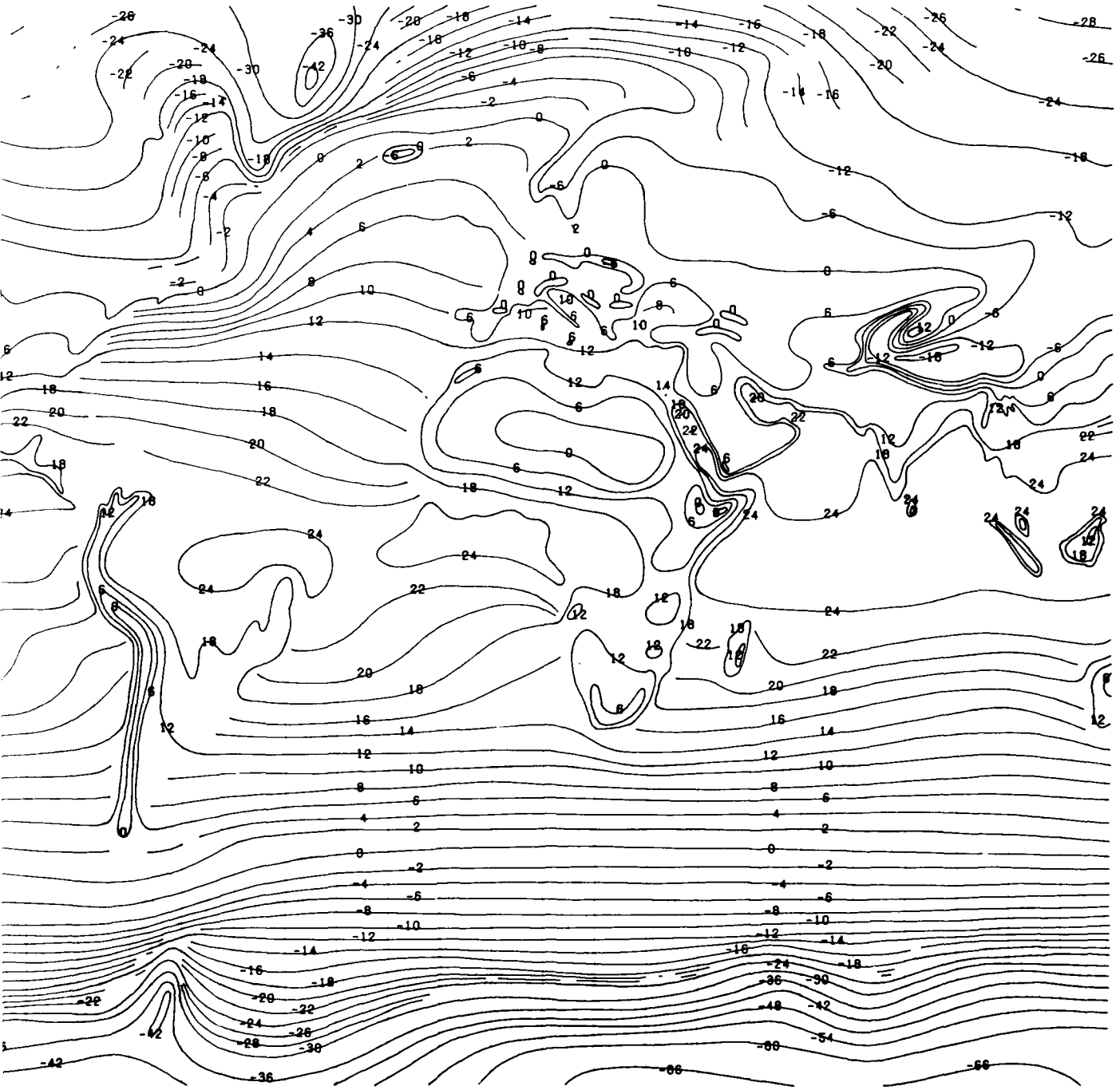


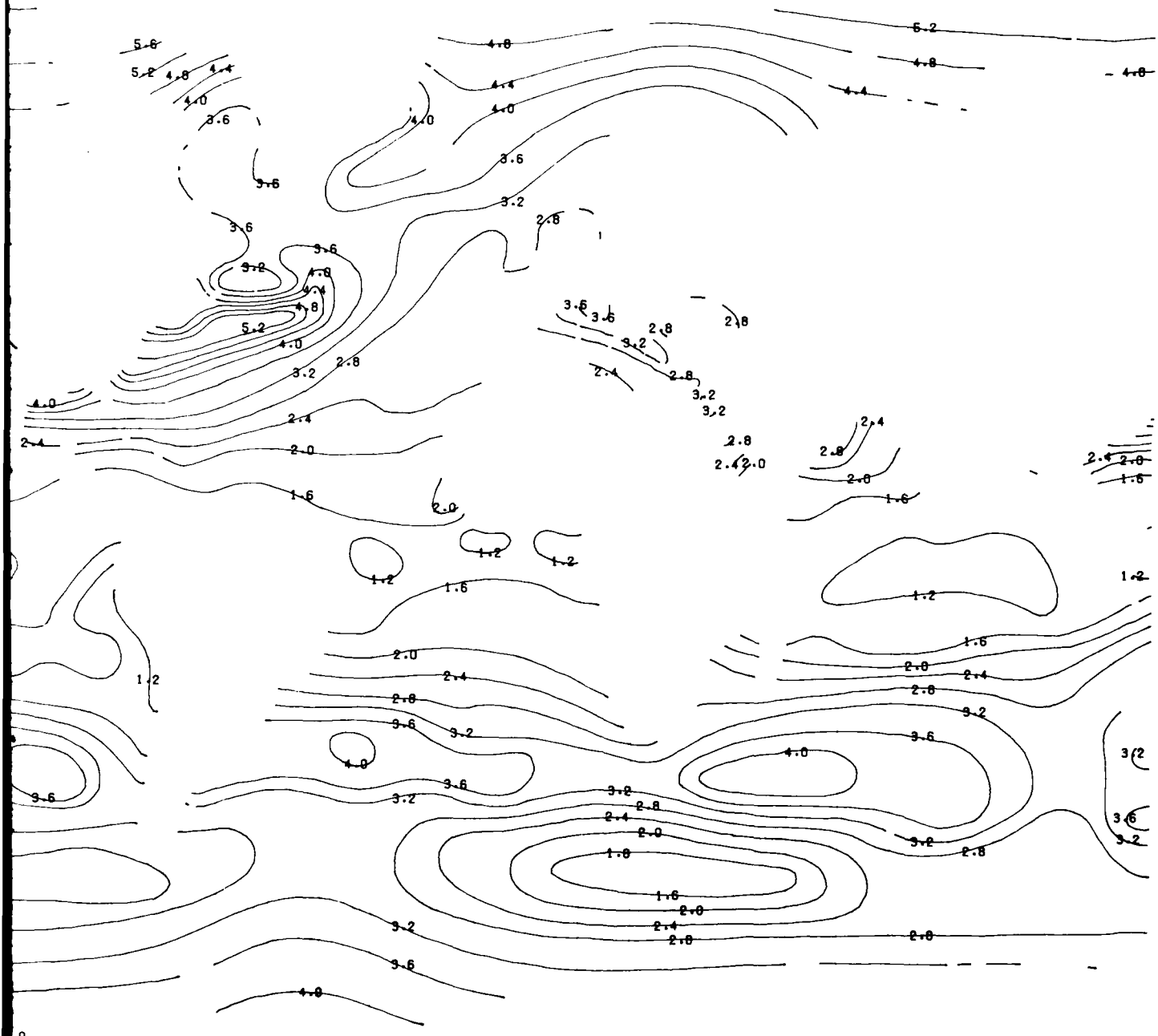
DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS

D DEVIATIONS

APRIL



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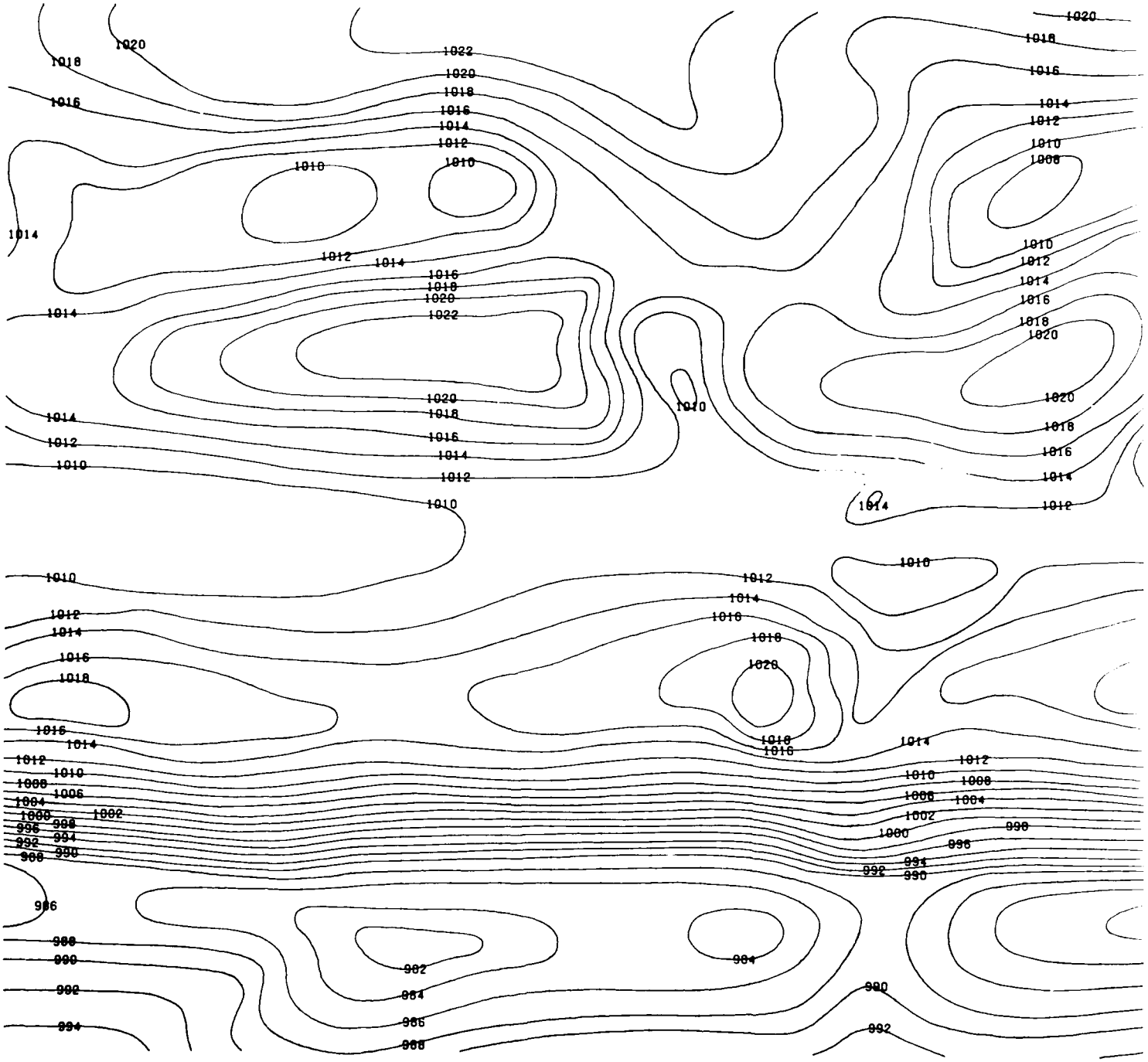
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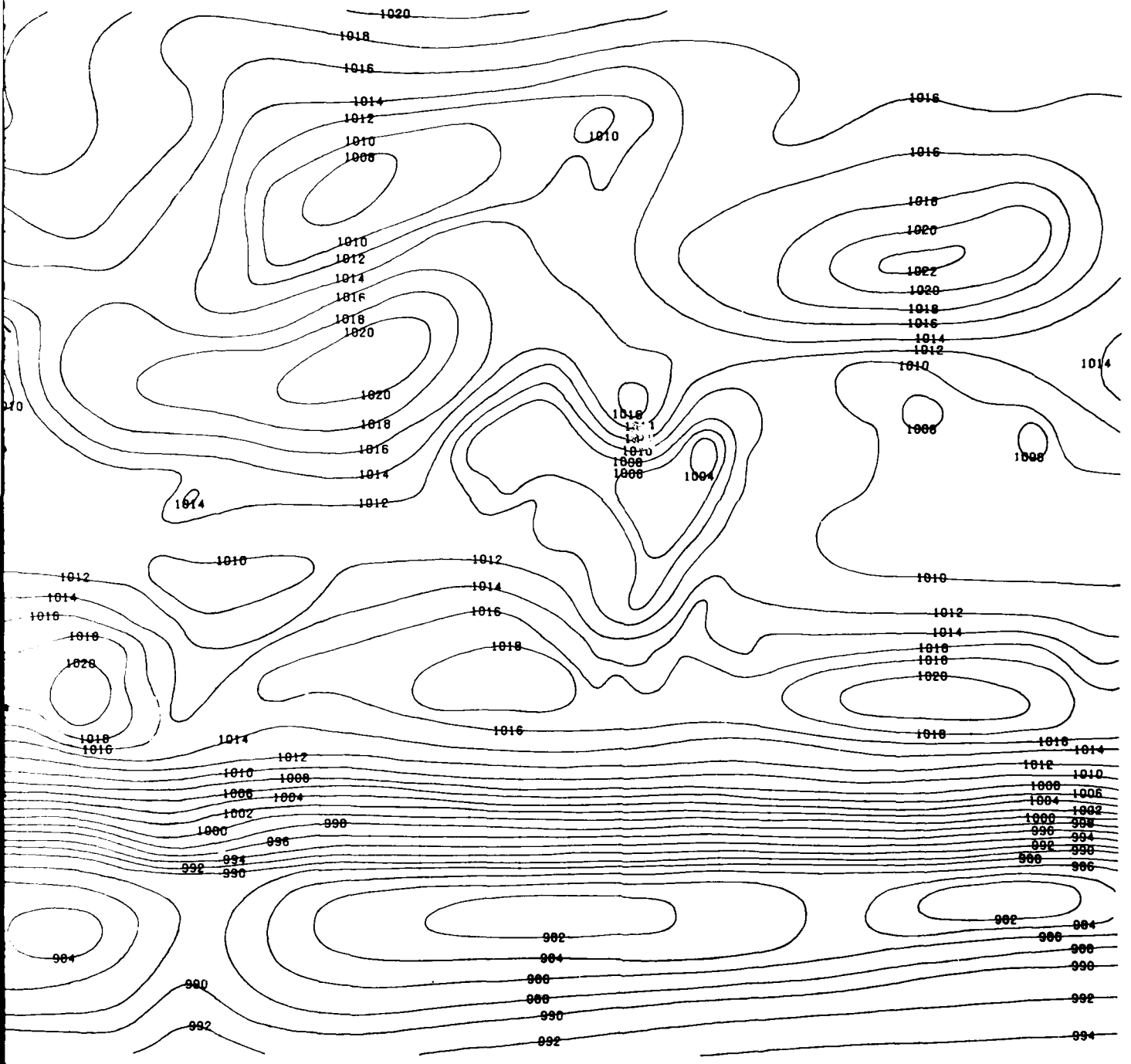
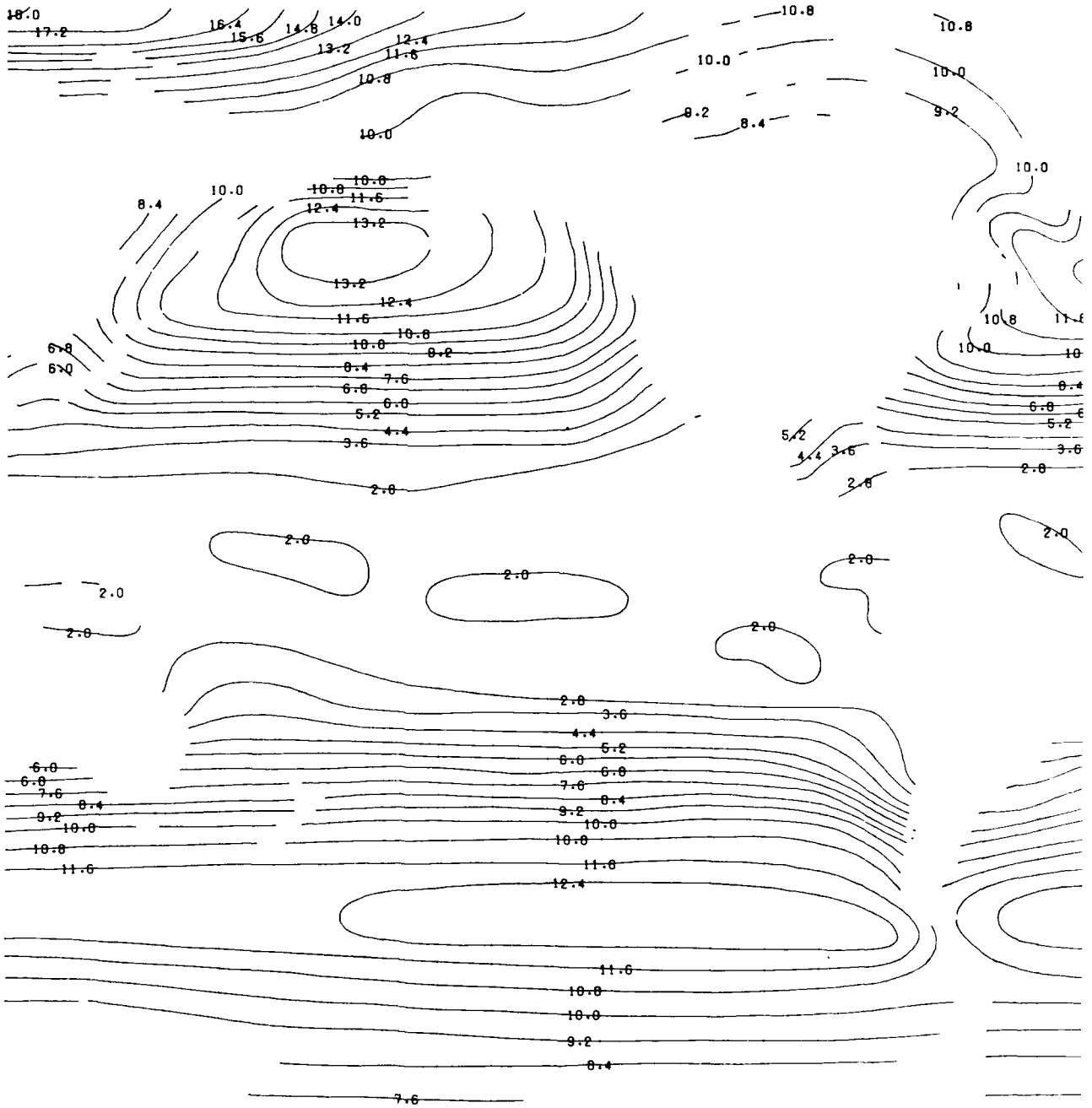
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



DEVIATIONS

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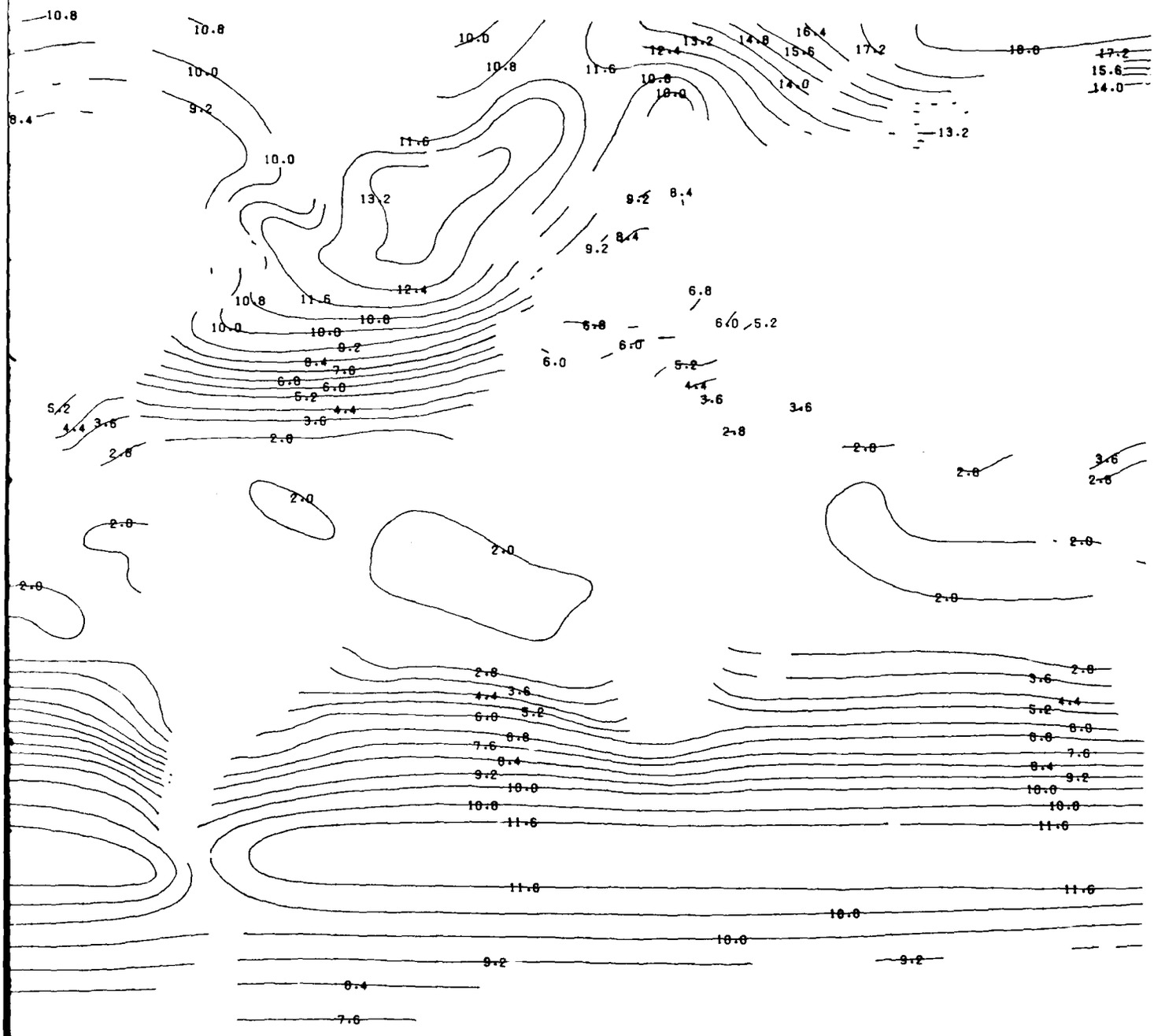

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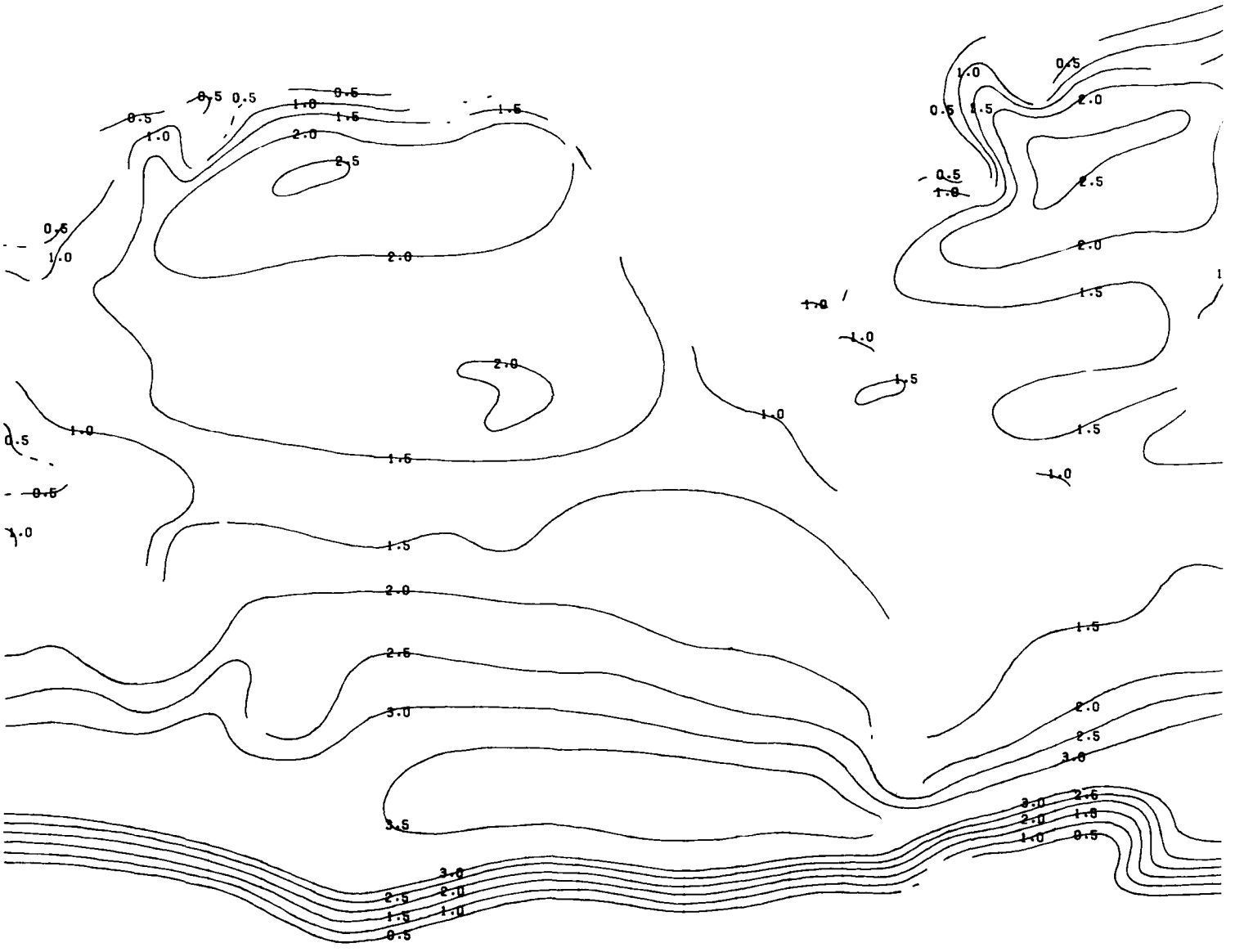
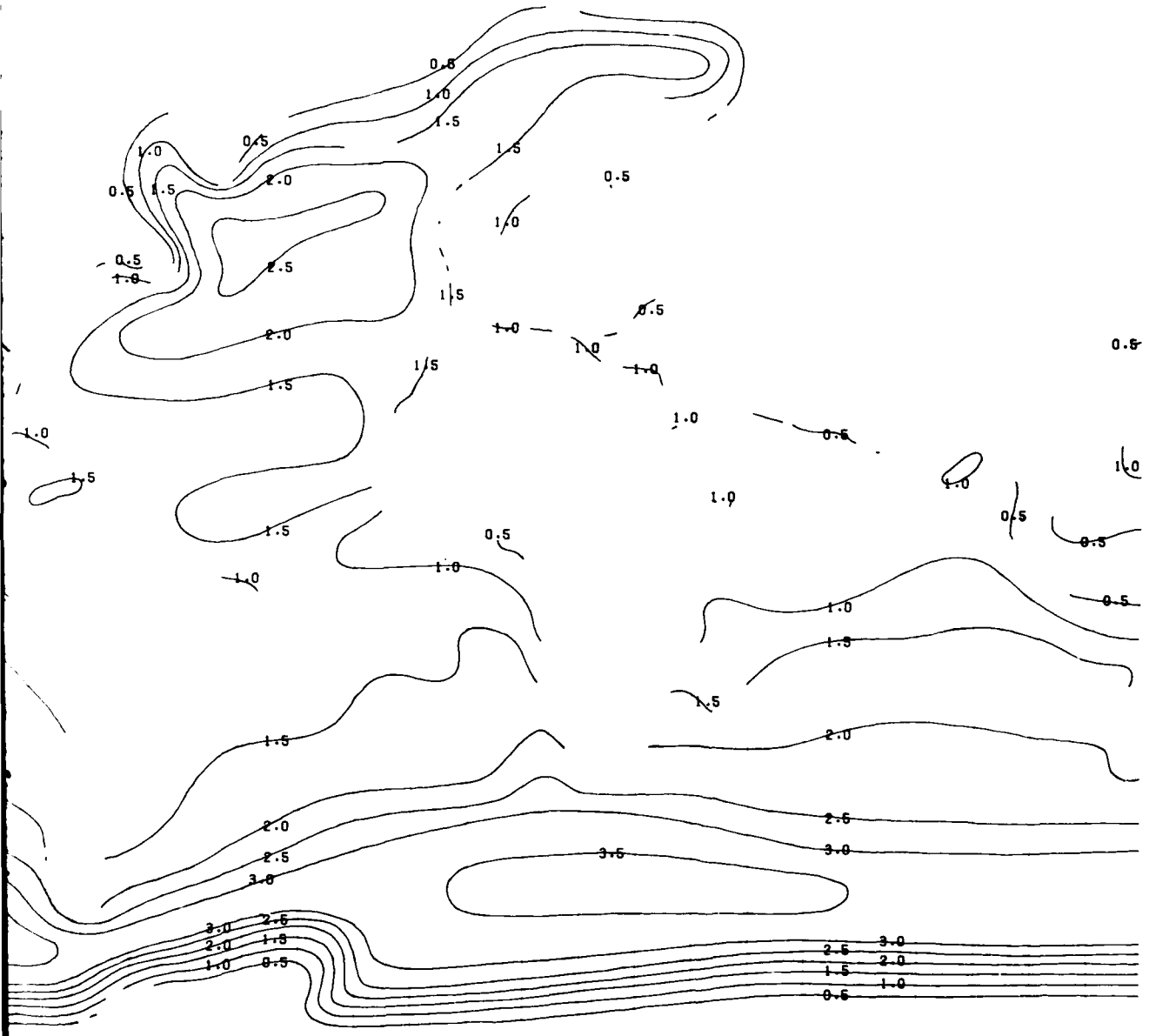
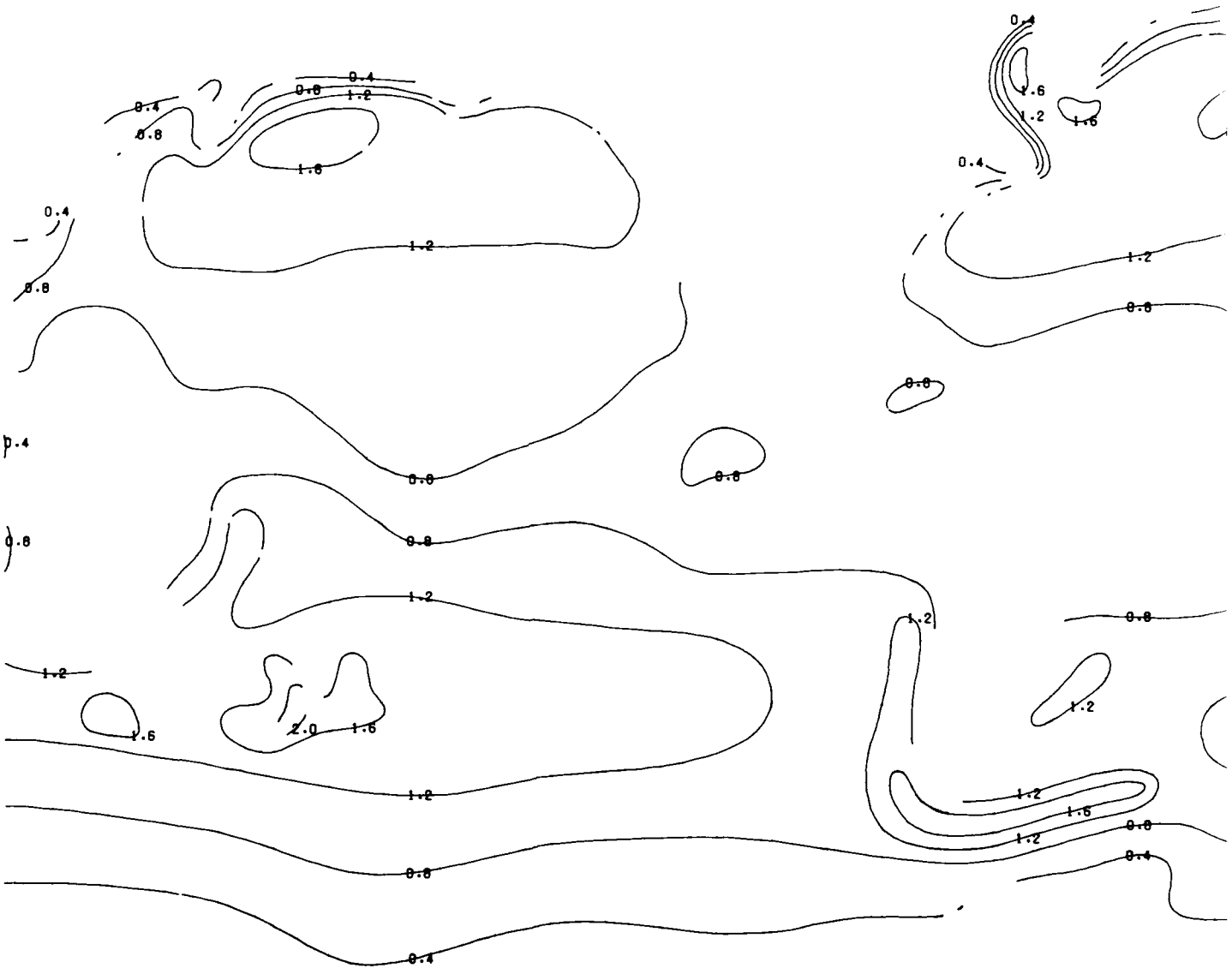


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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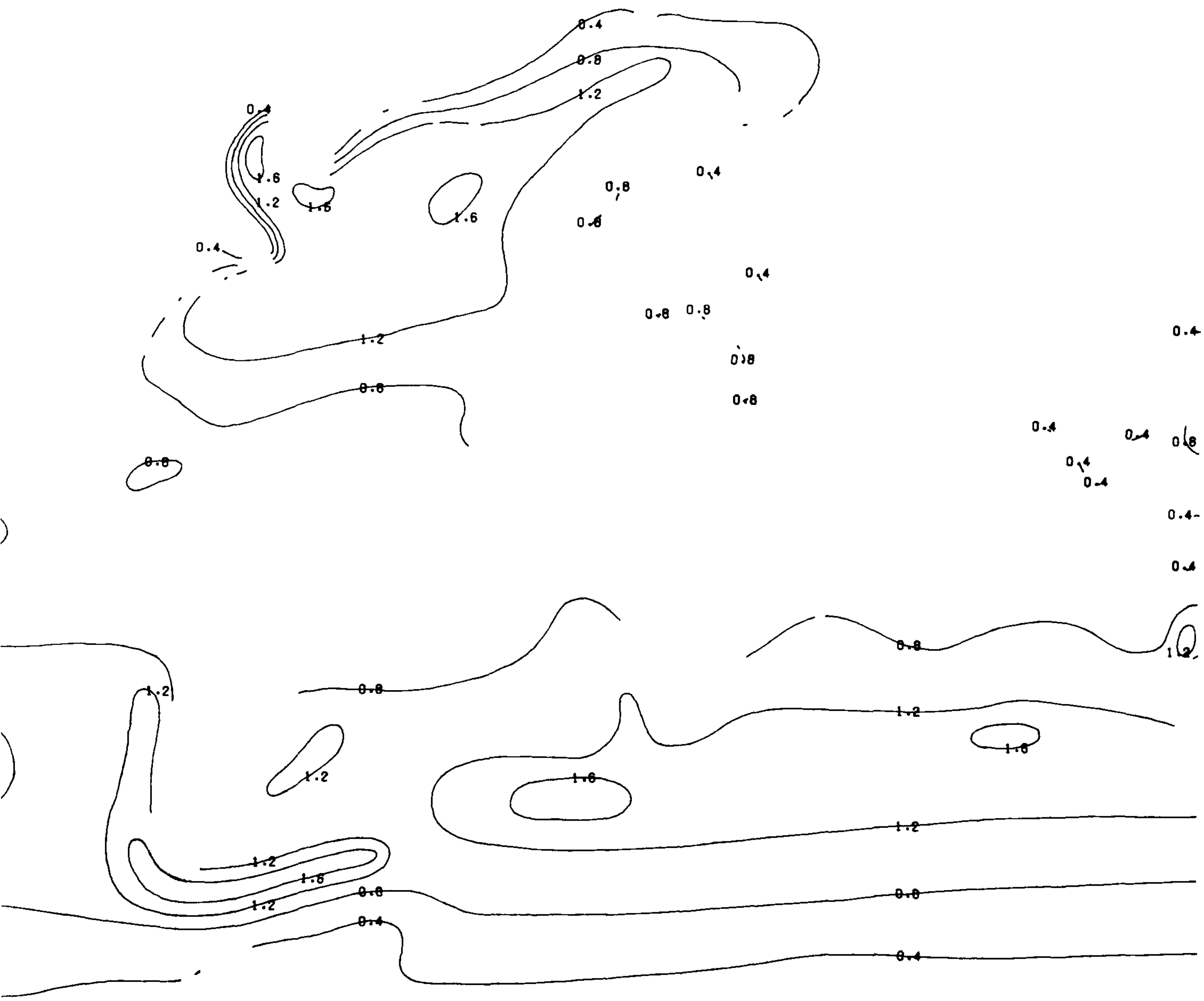

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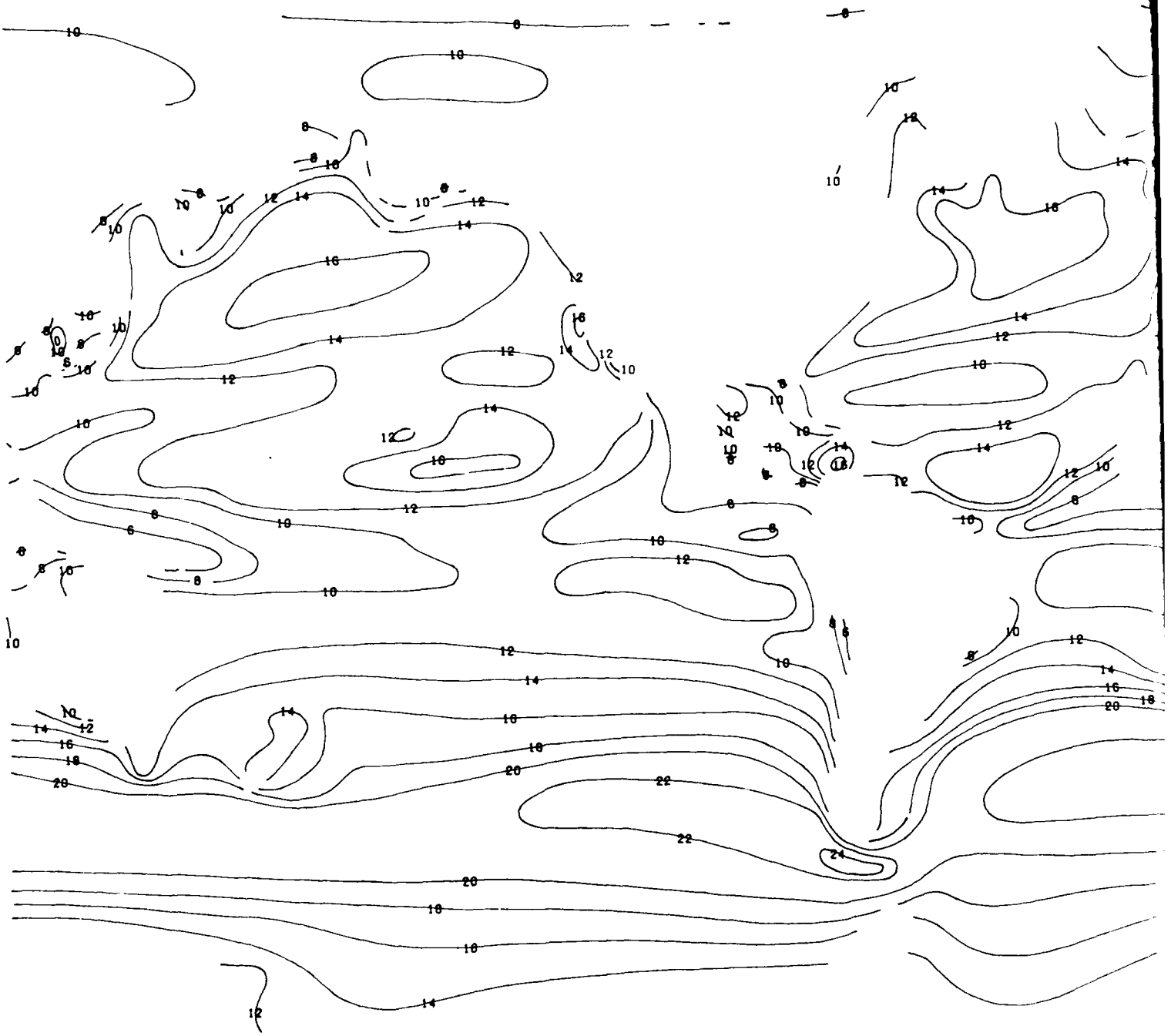
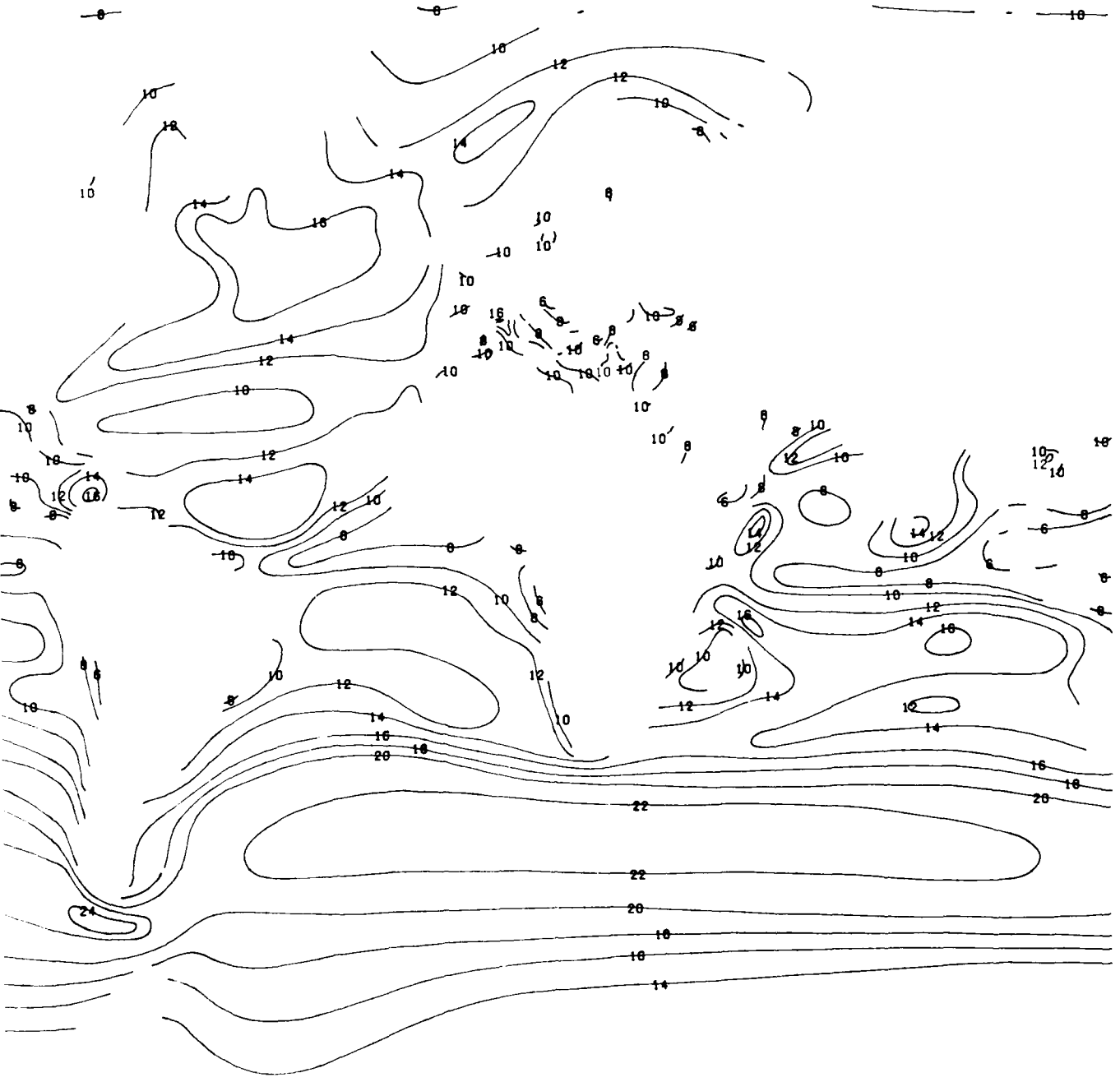
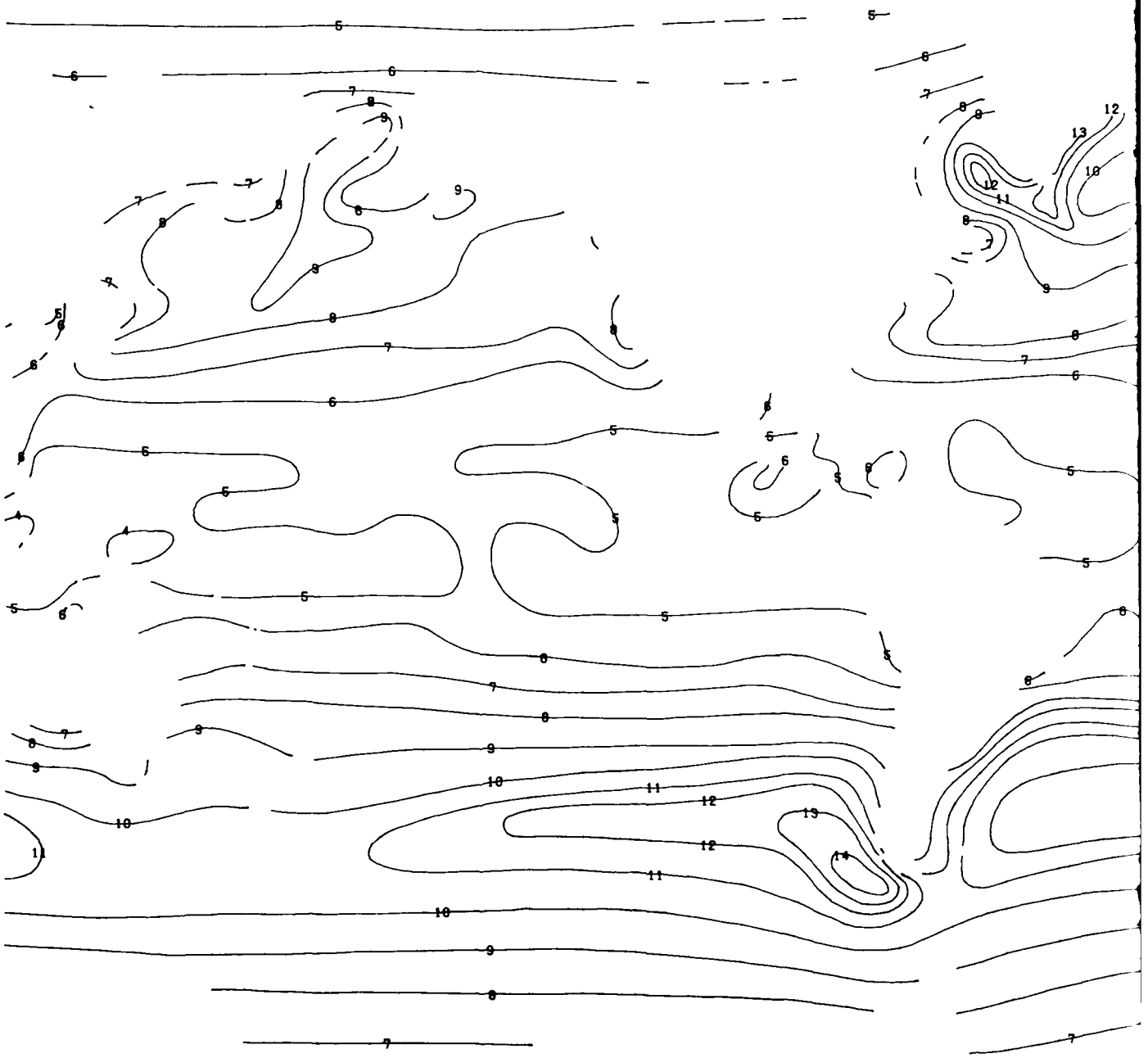
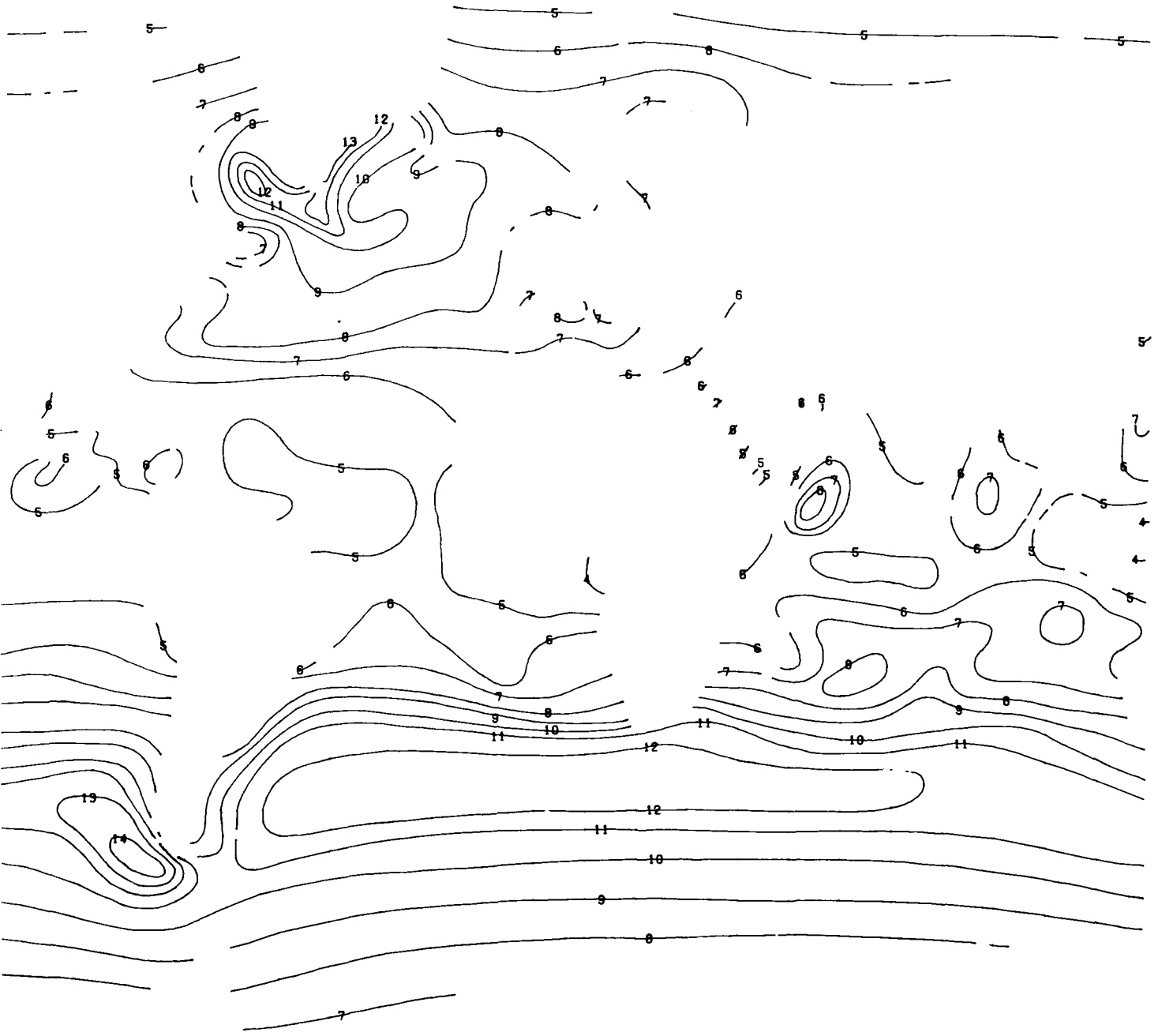


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS





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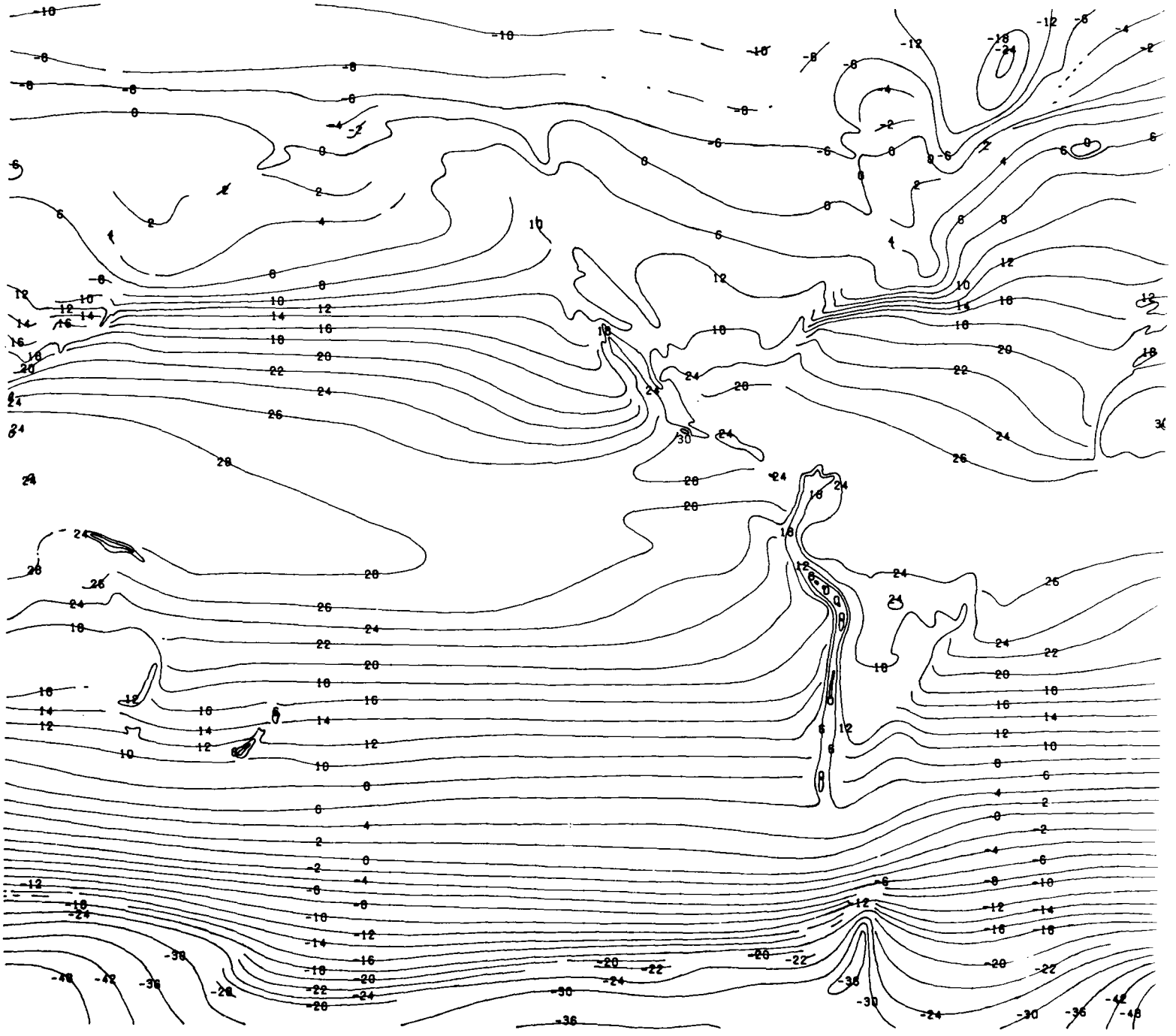
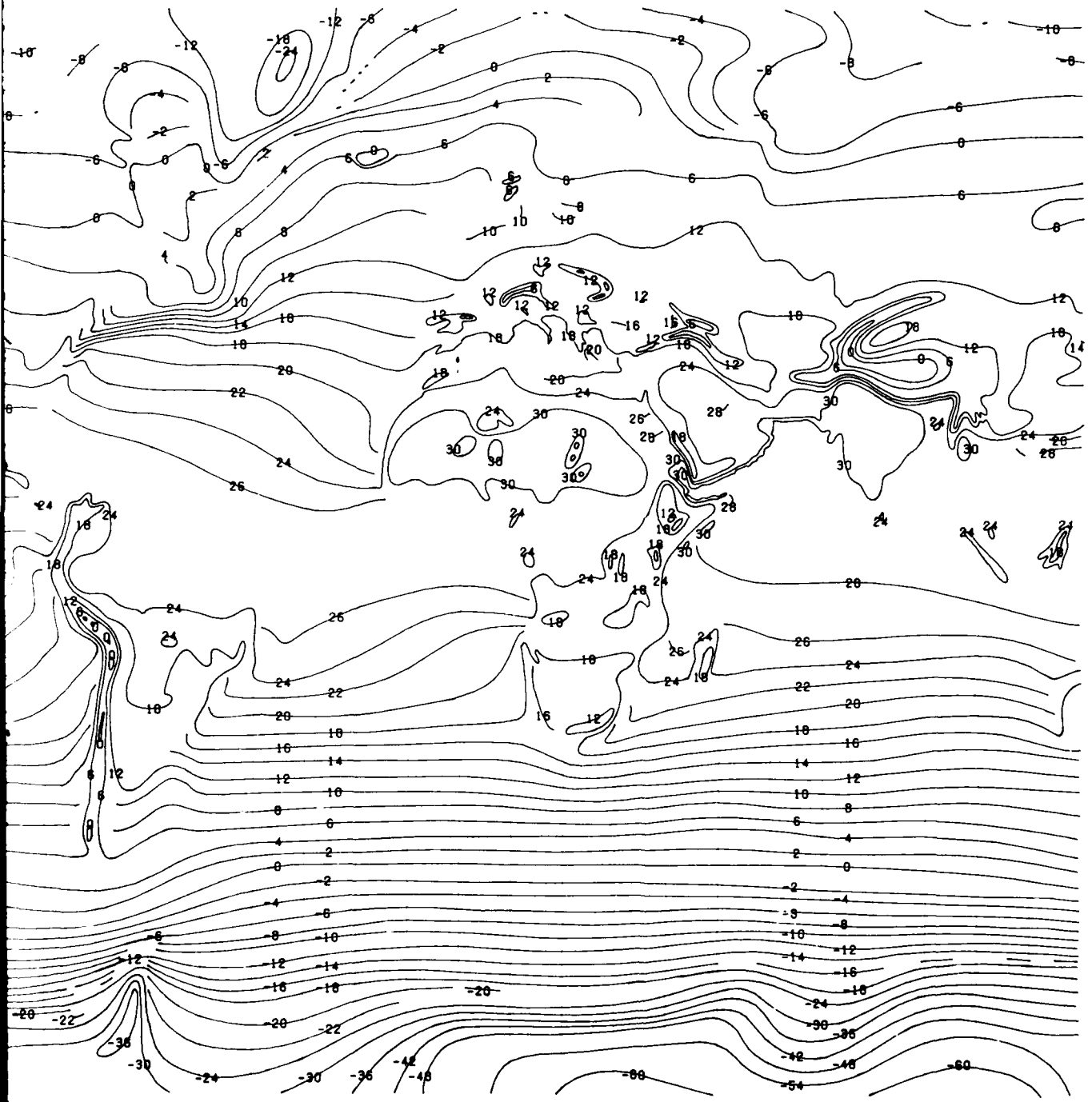
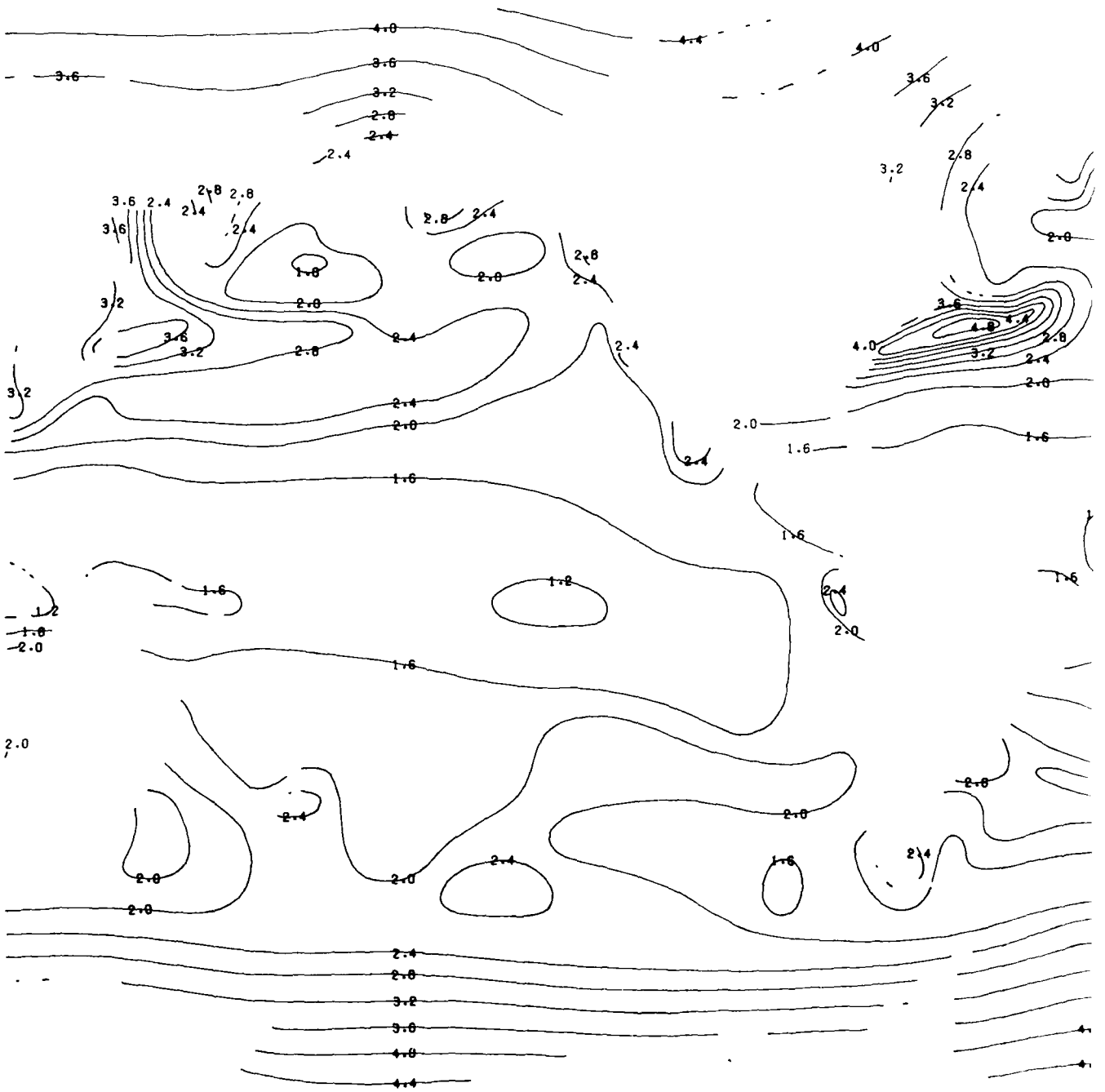


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



NDARD DEVIATIONS

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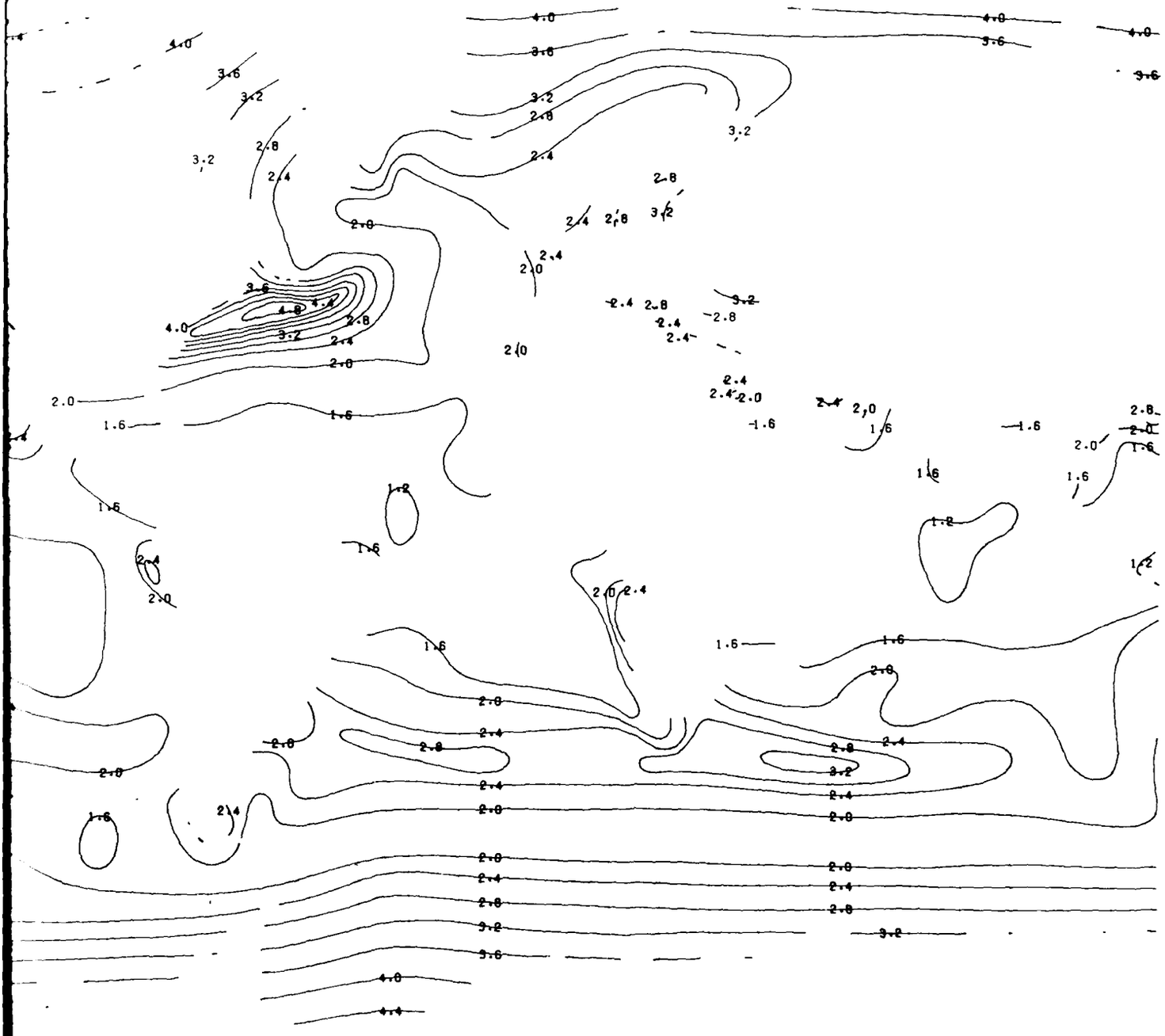

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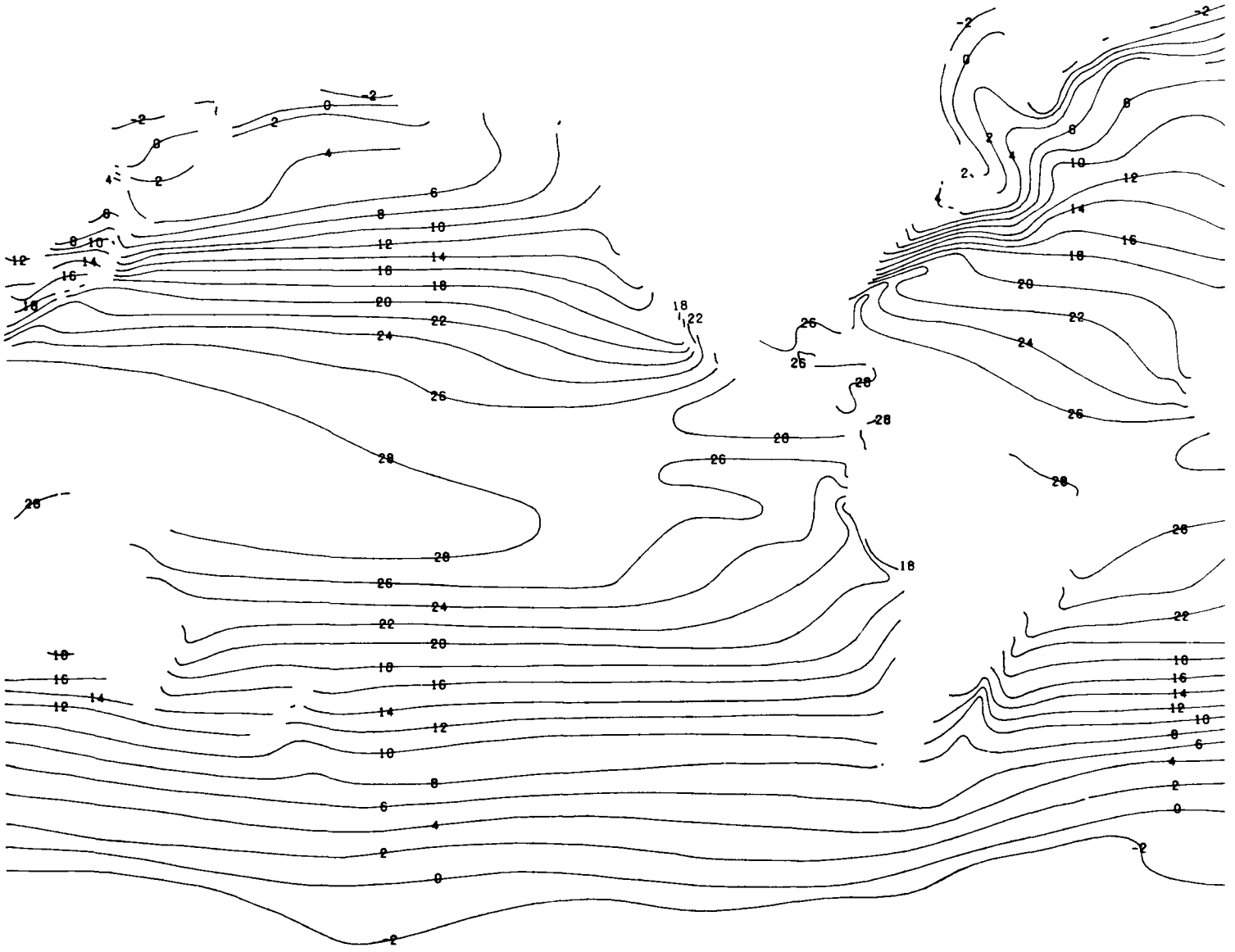
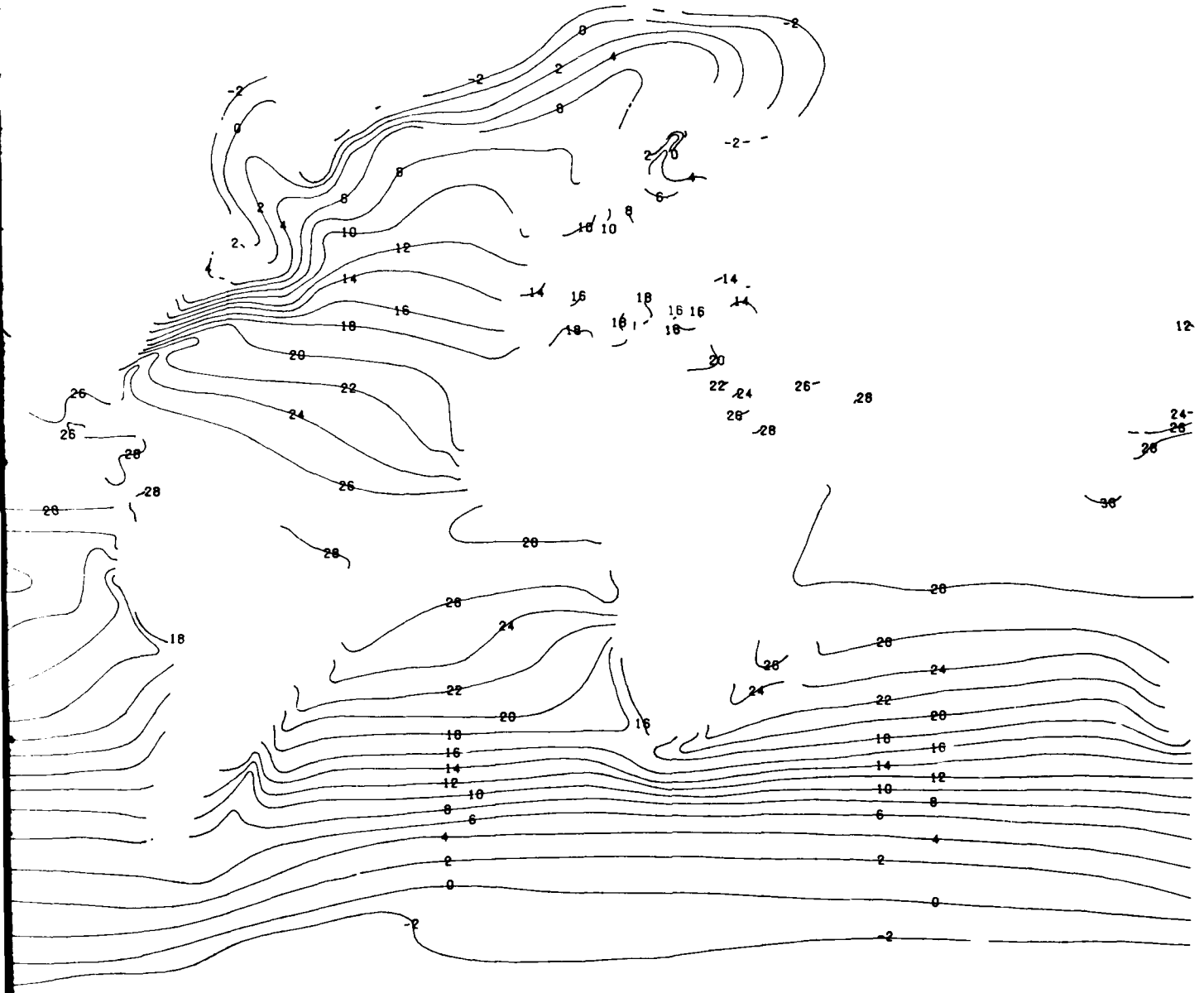
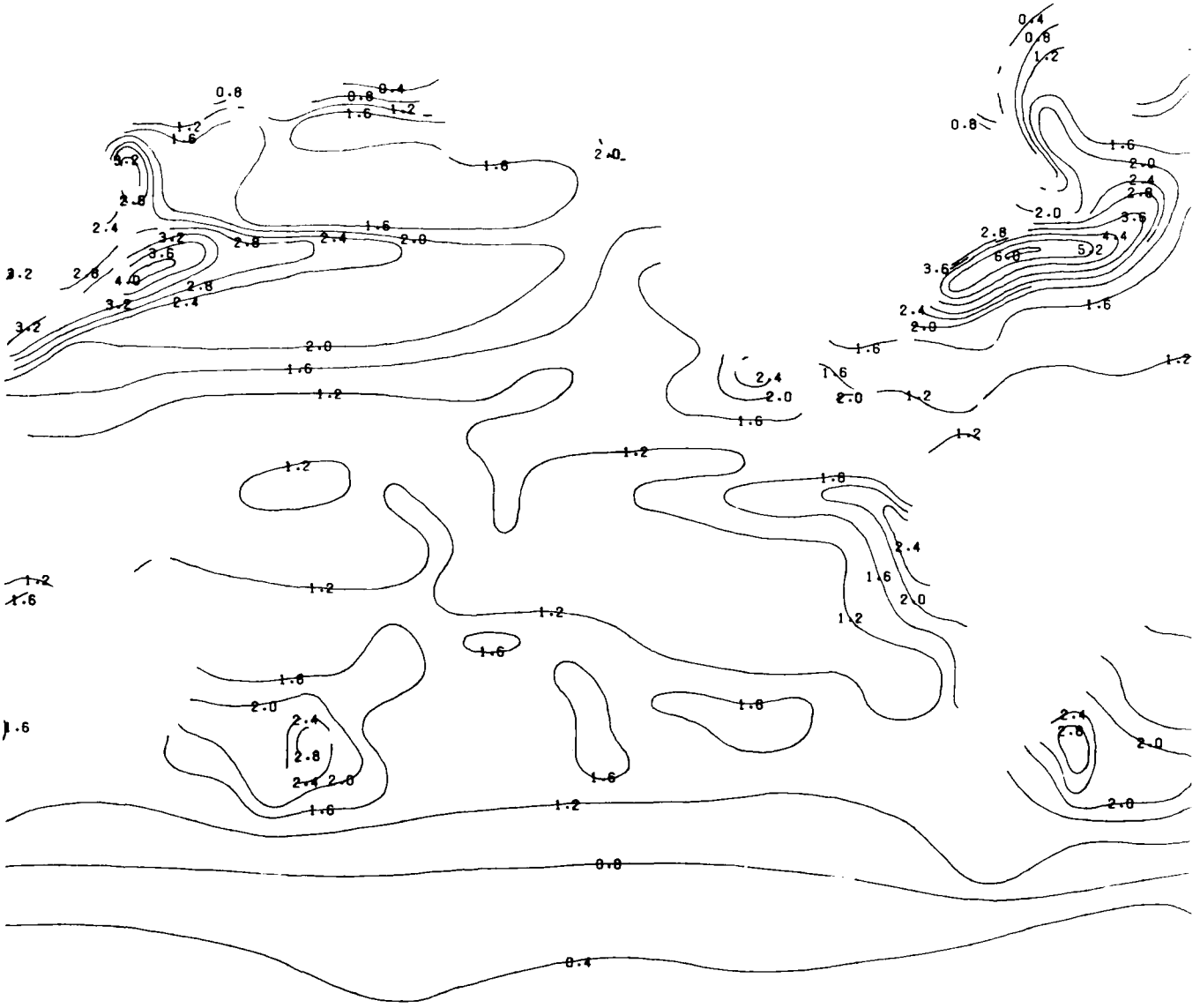


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



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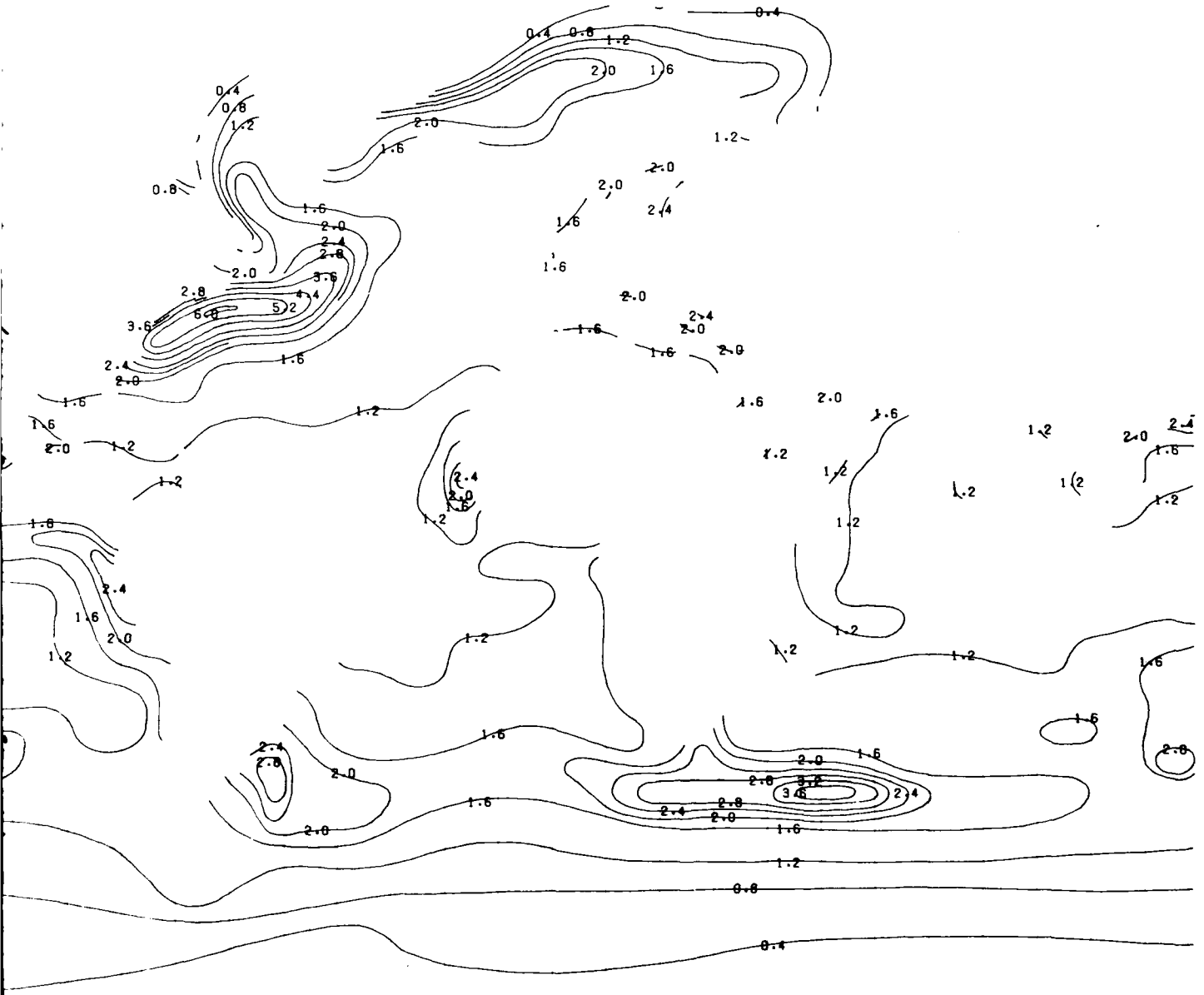

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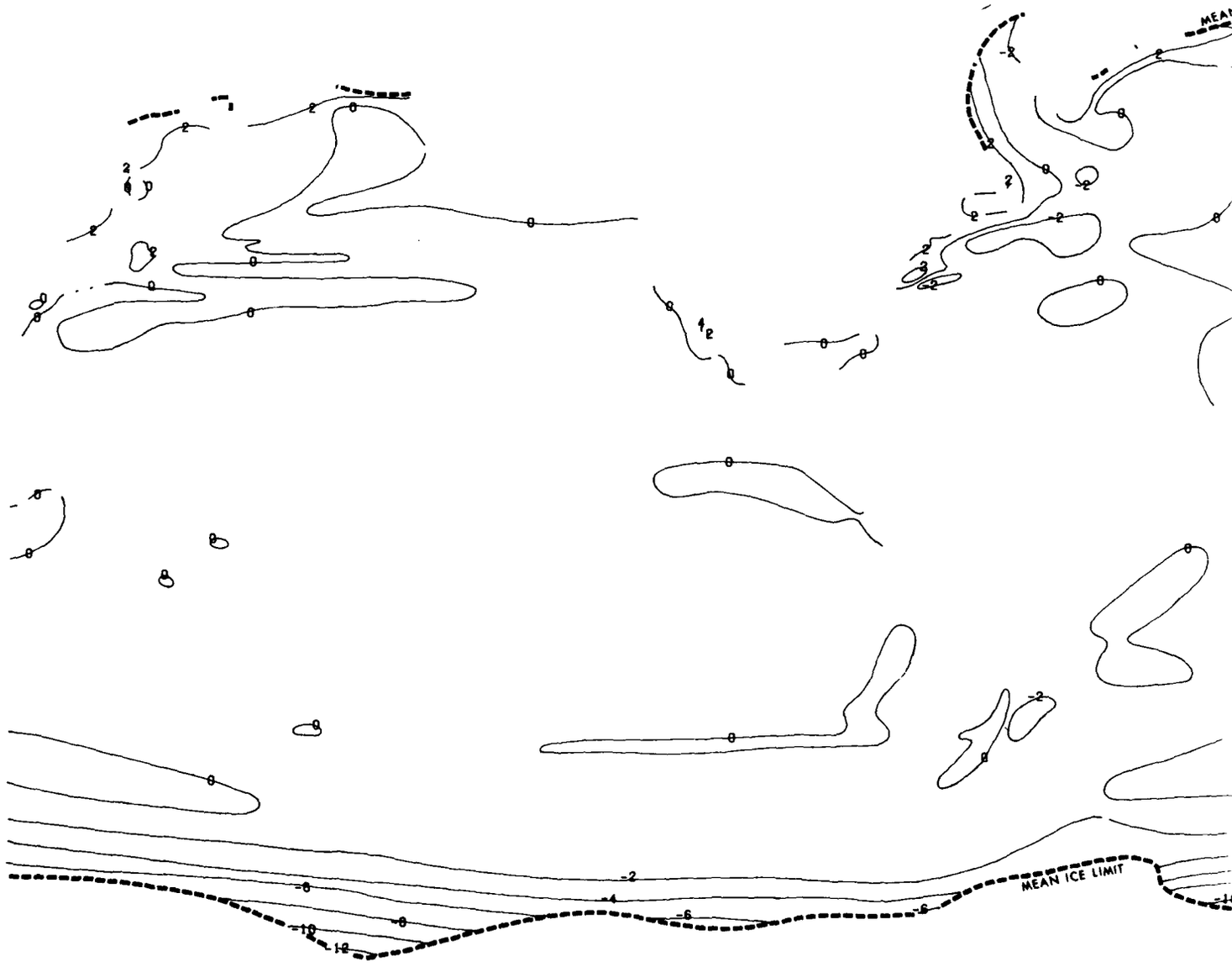
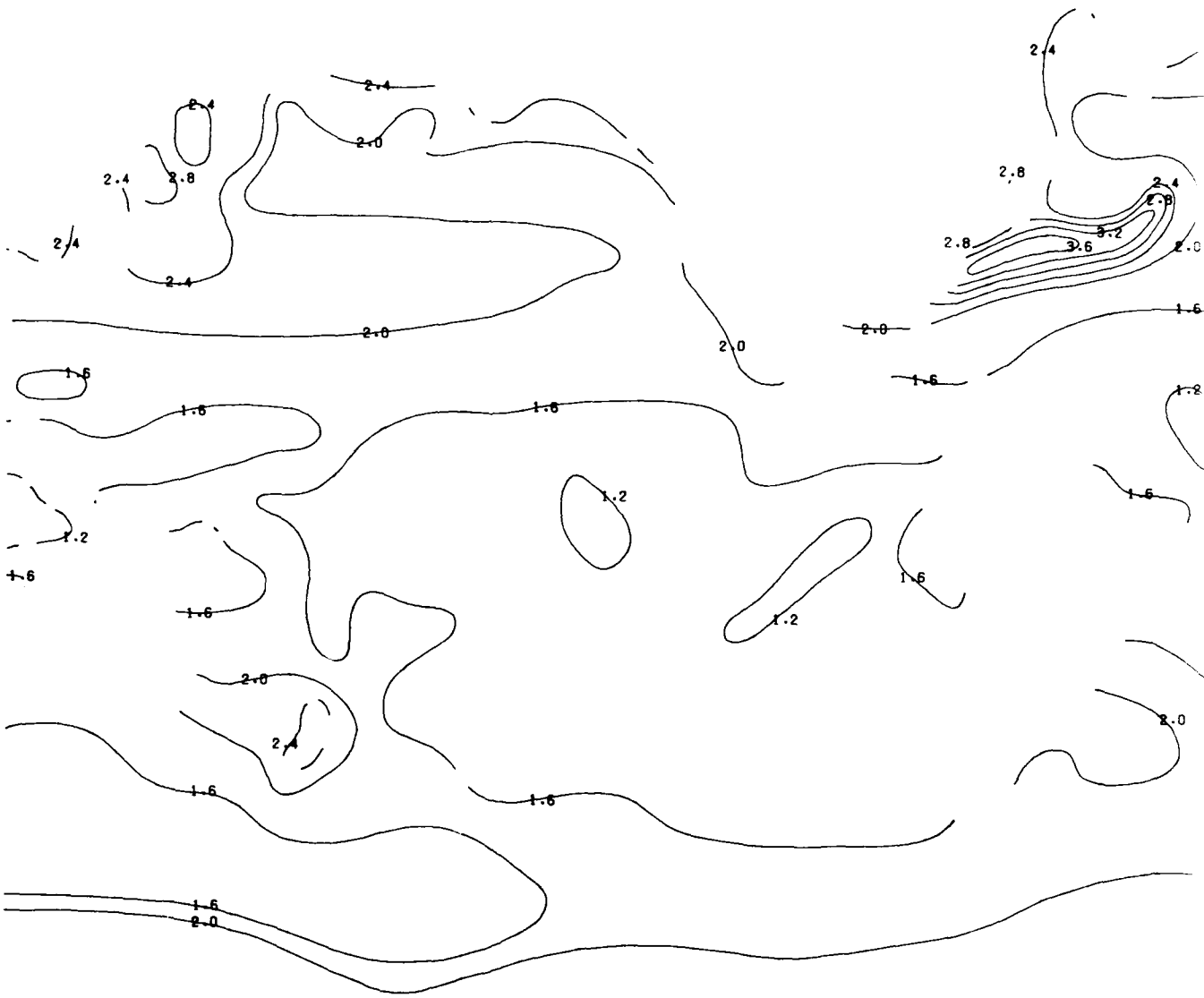
AIR-SEA



AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATION



STANDARD DEVIATIONS

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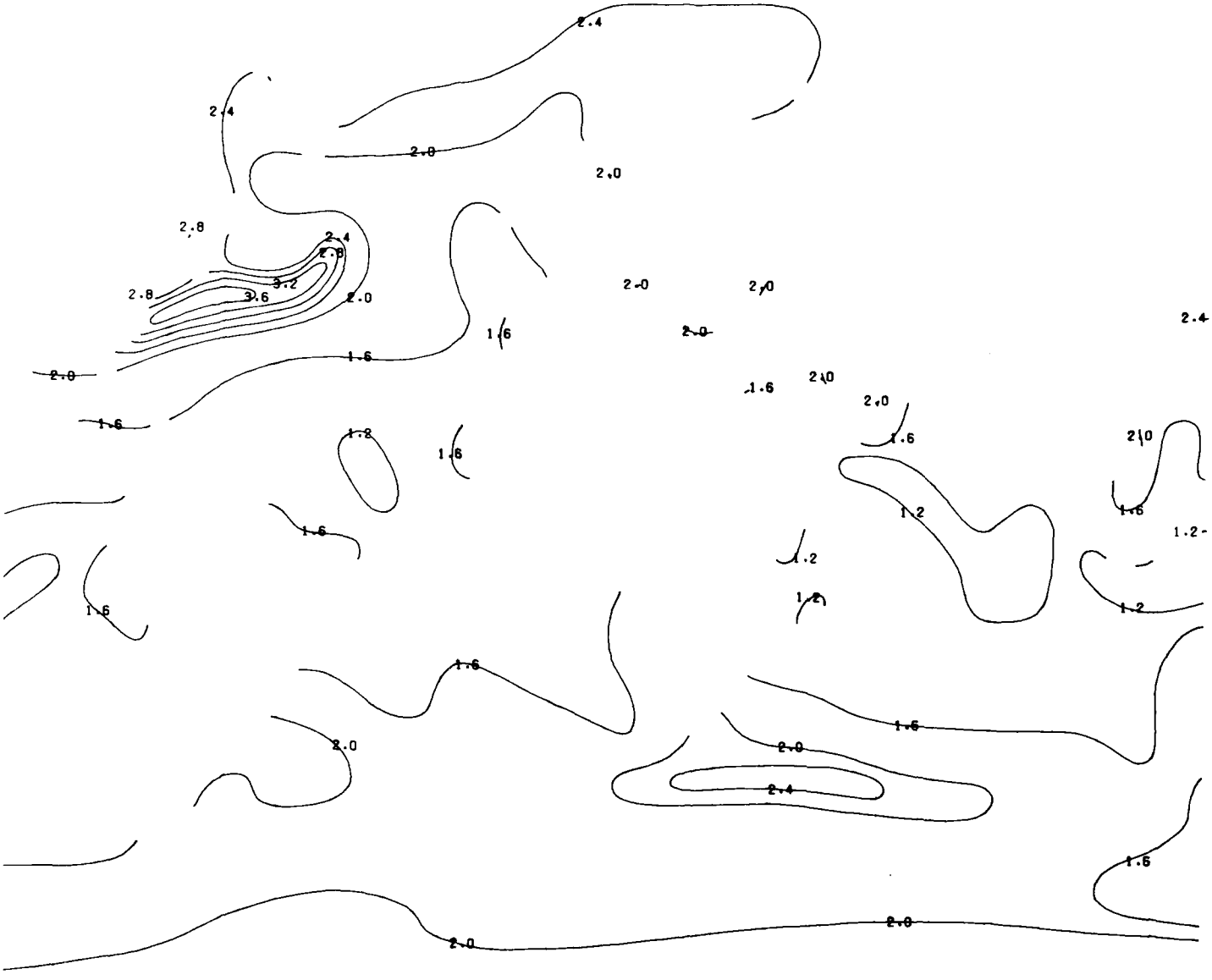

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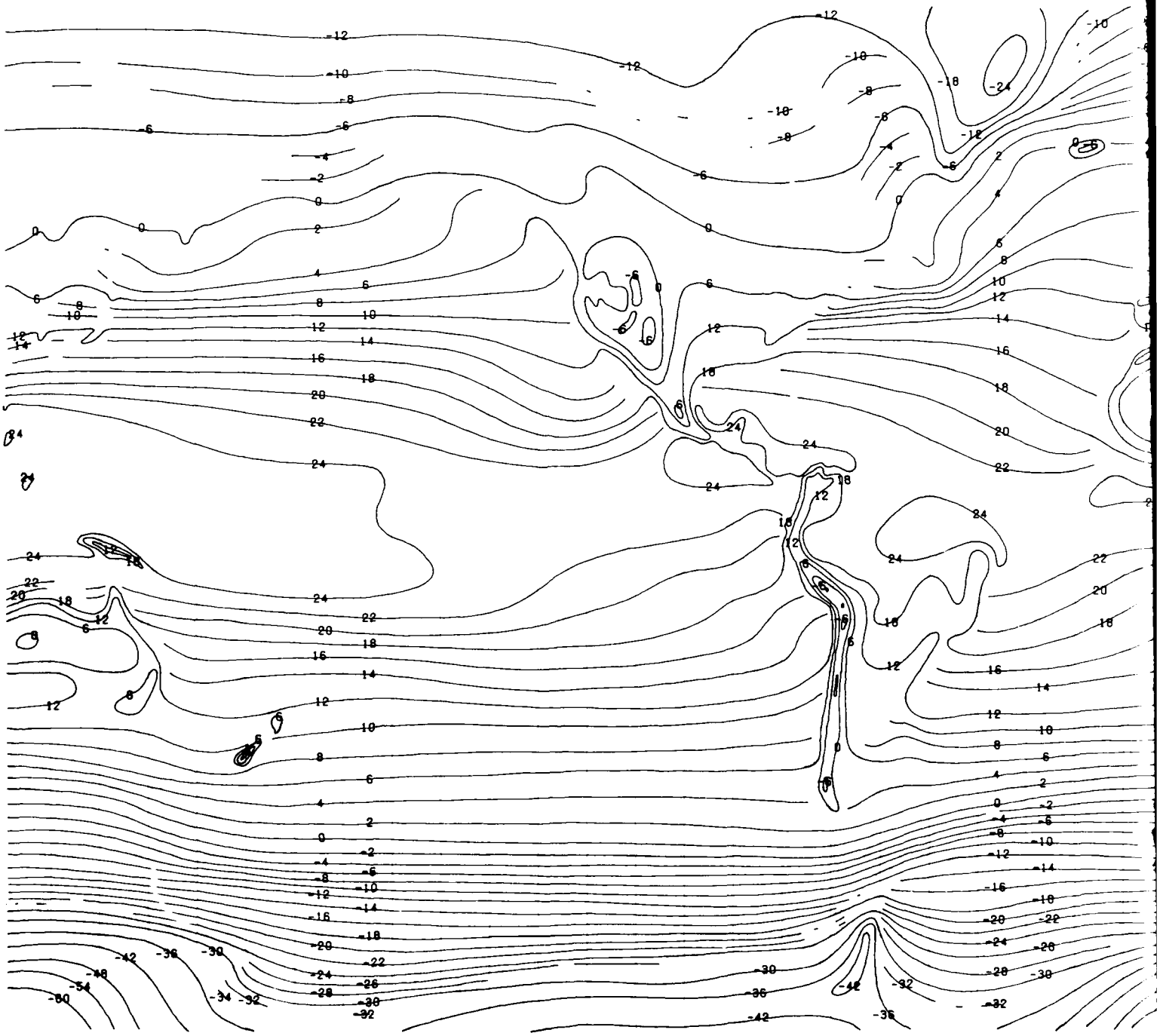
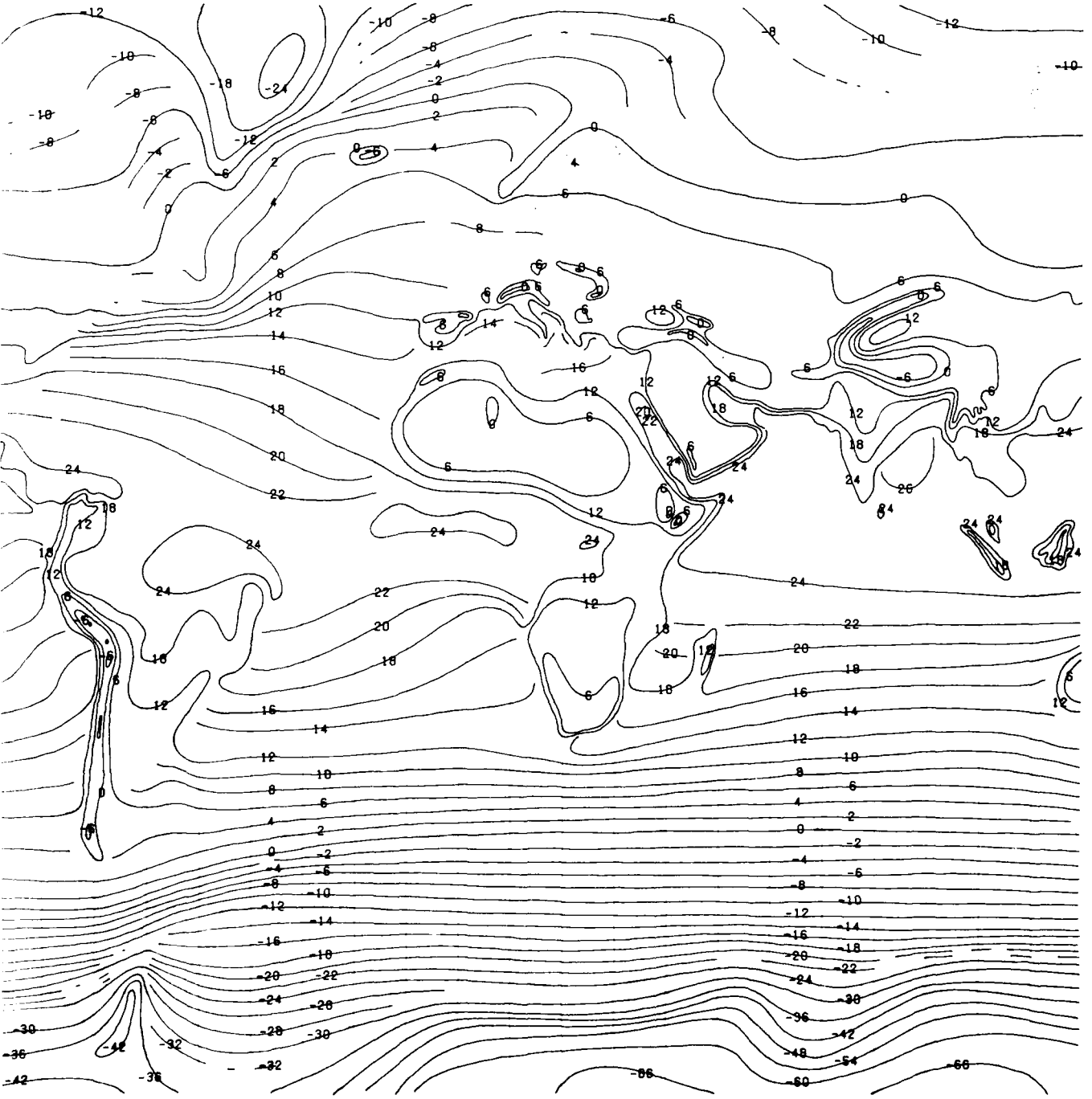
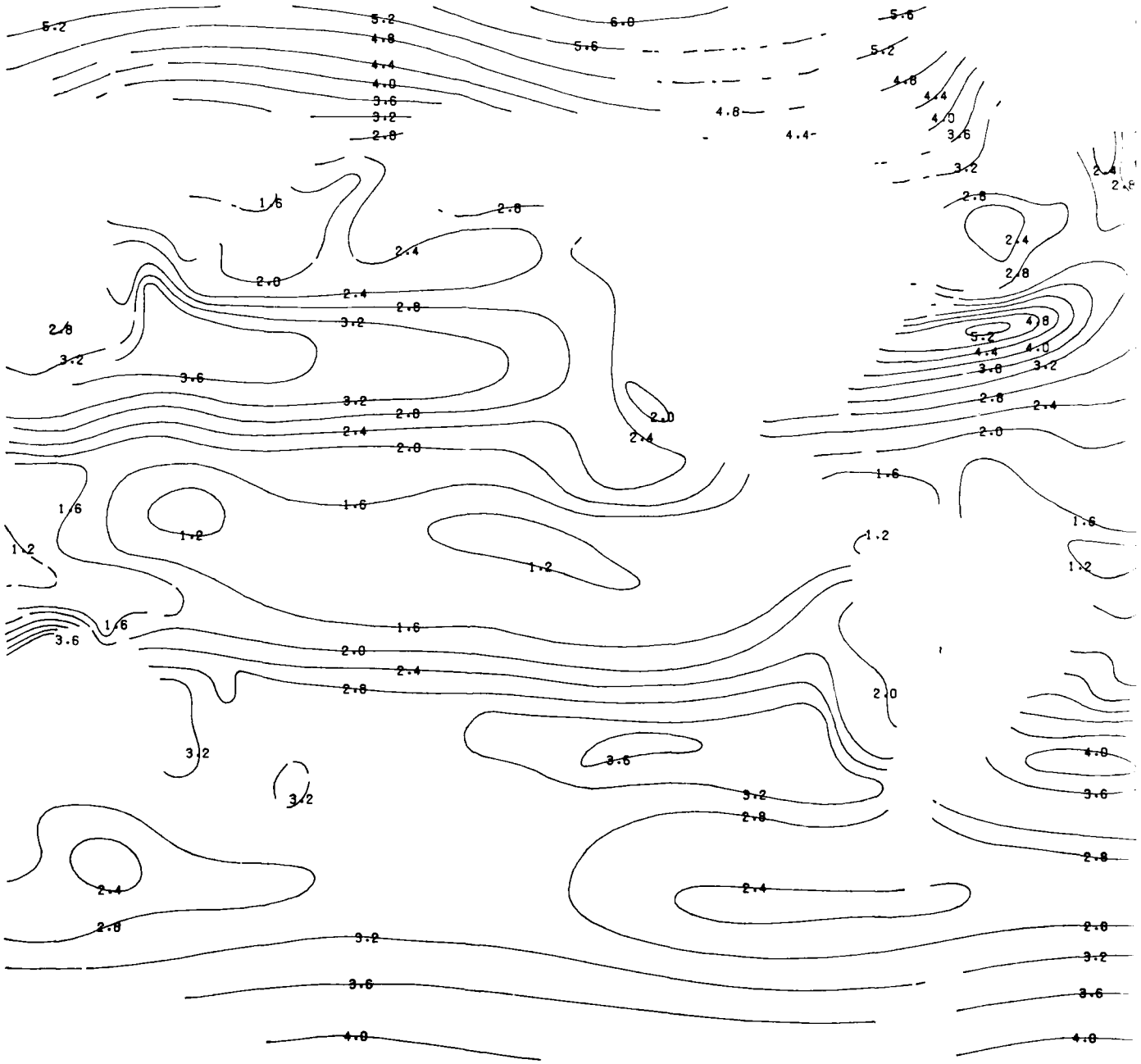
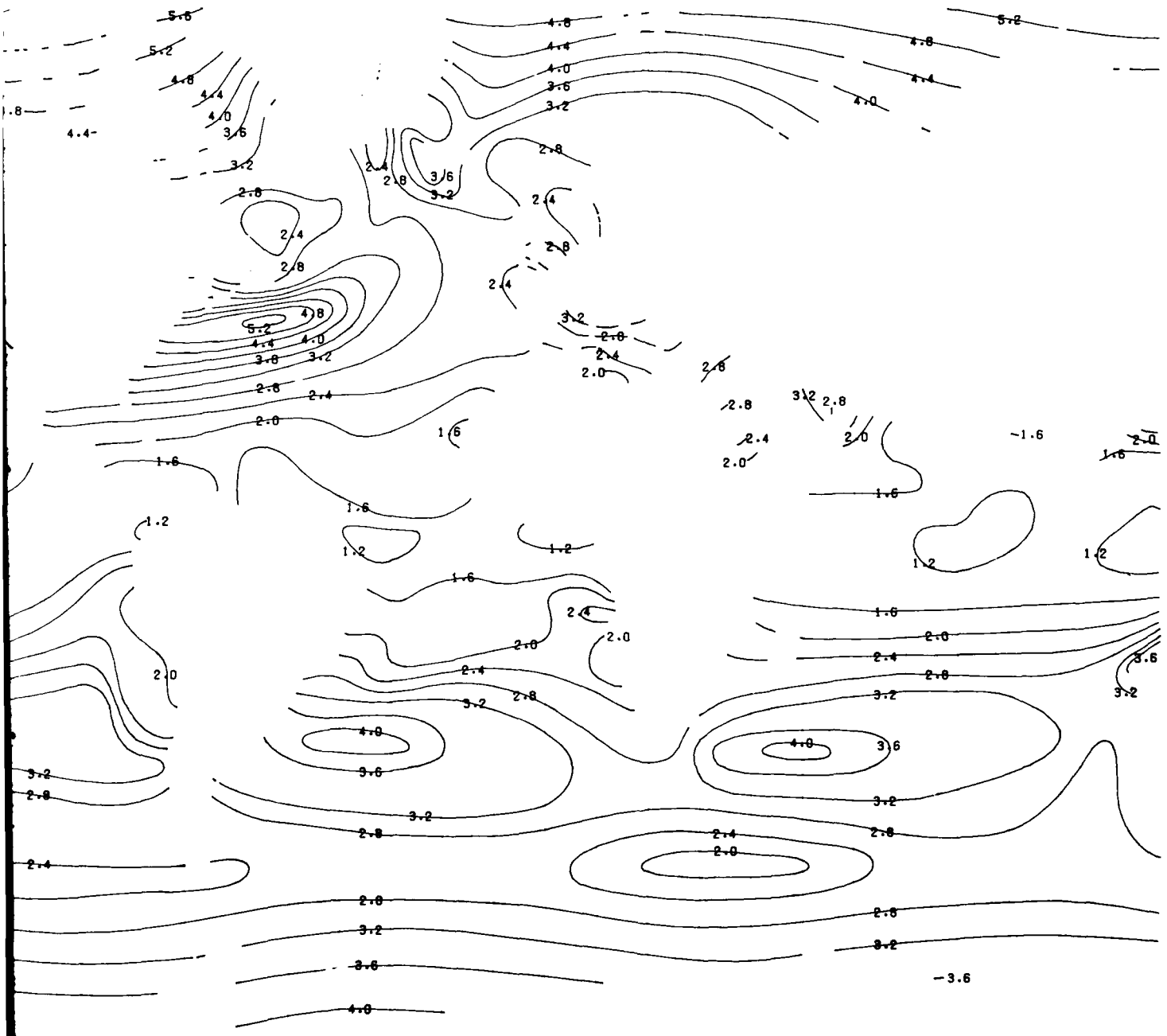


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS

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-1.6
-3.6

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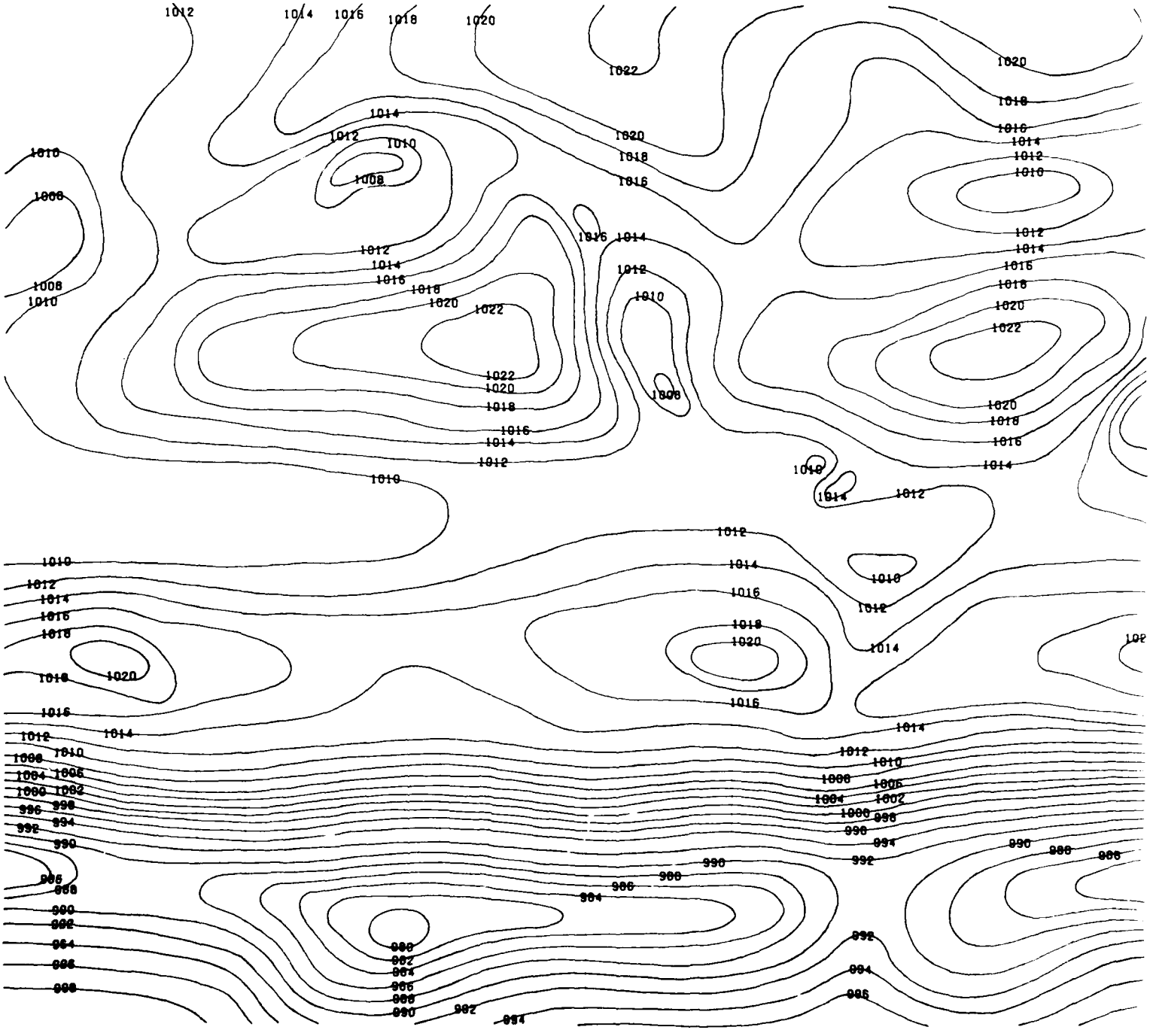
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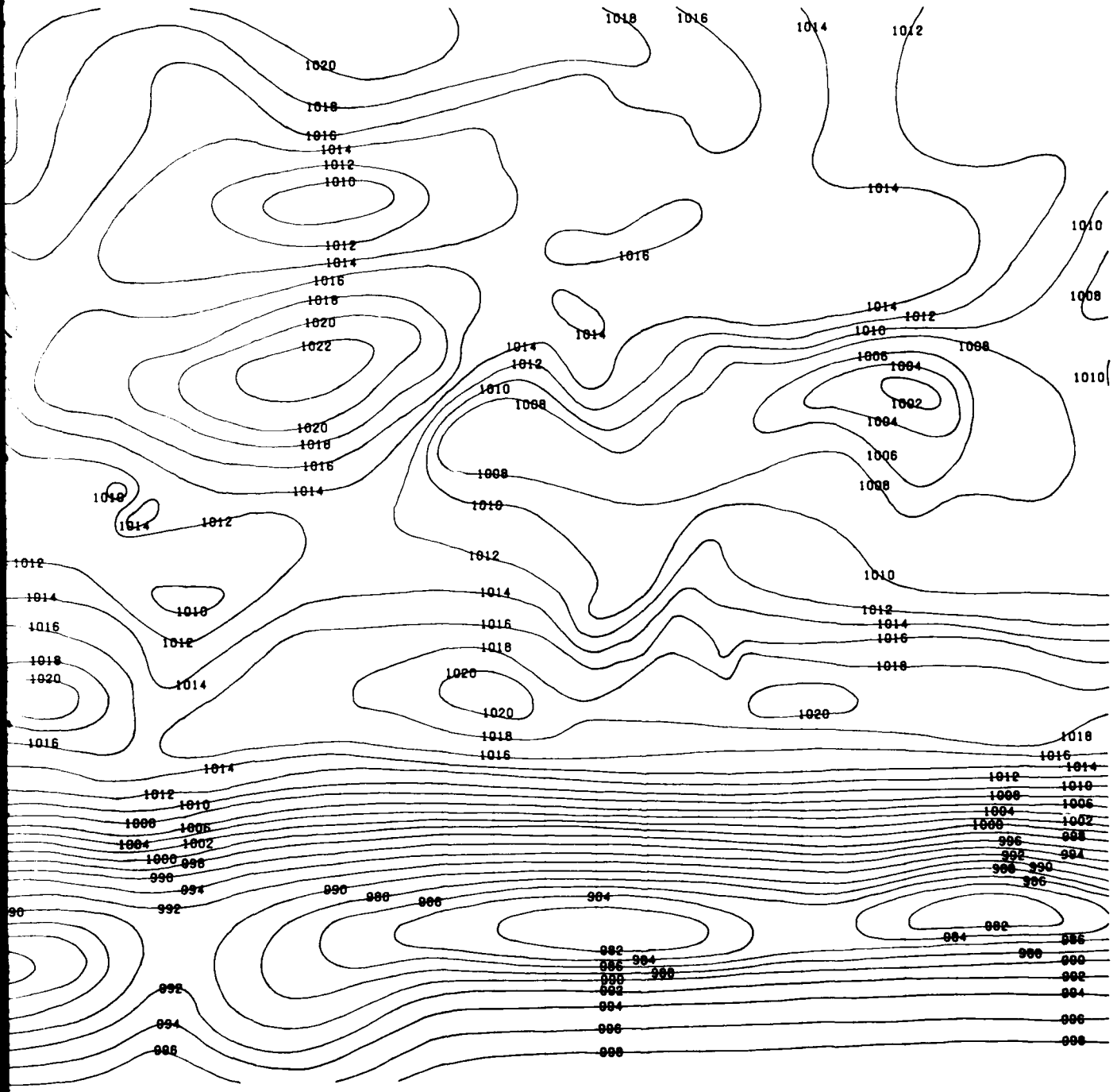
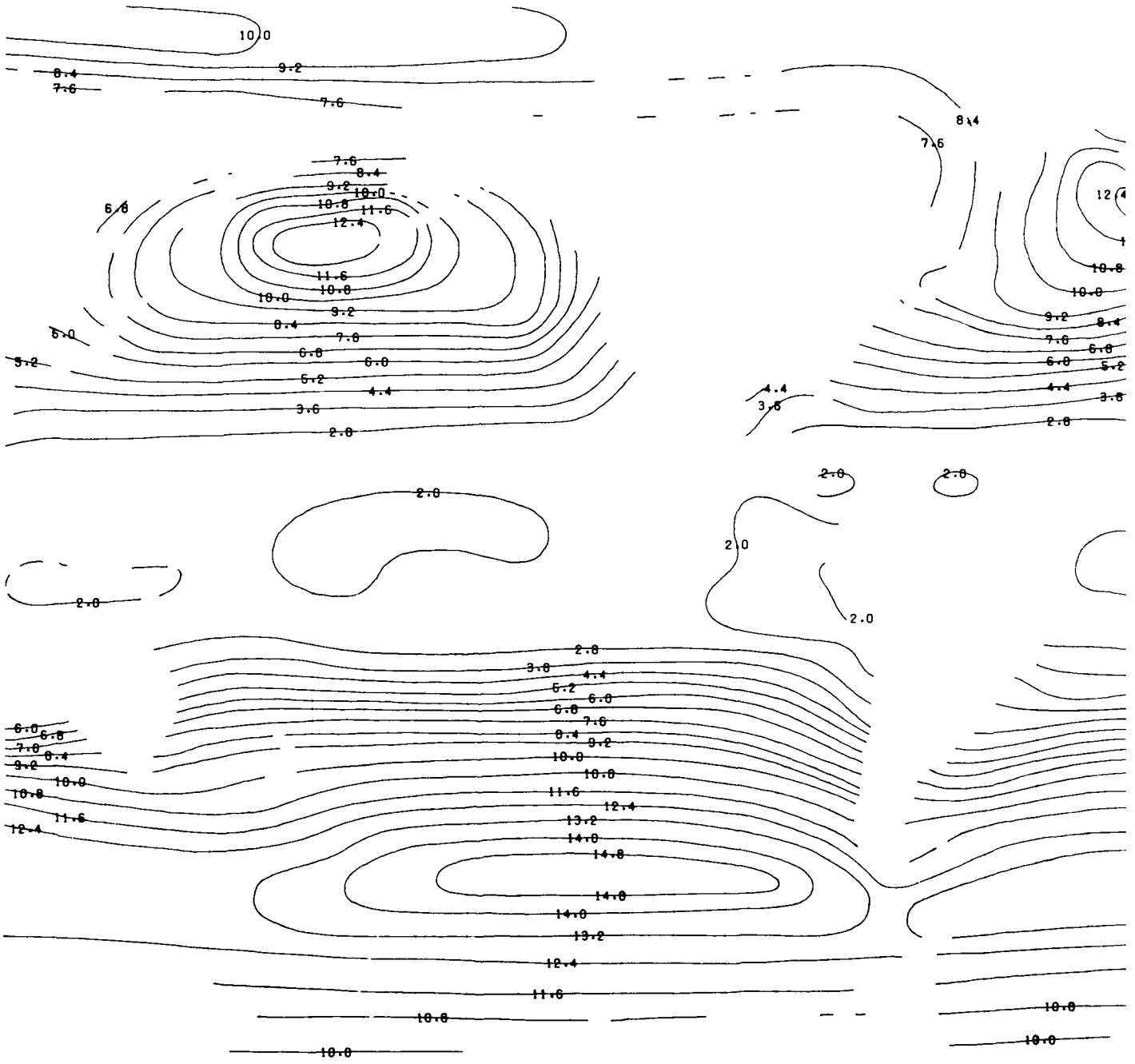
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



) DEVIATIONS

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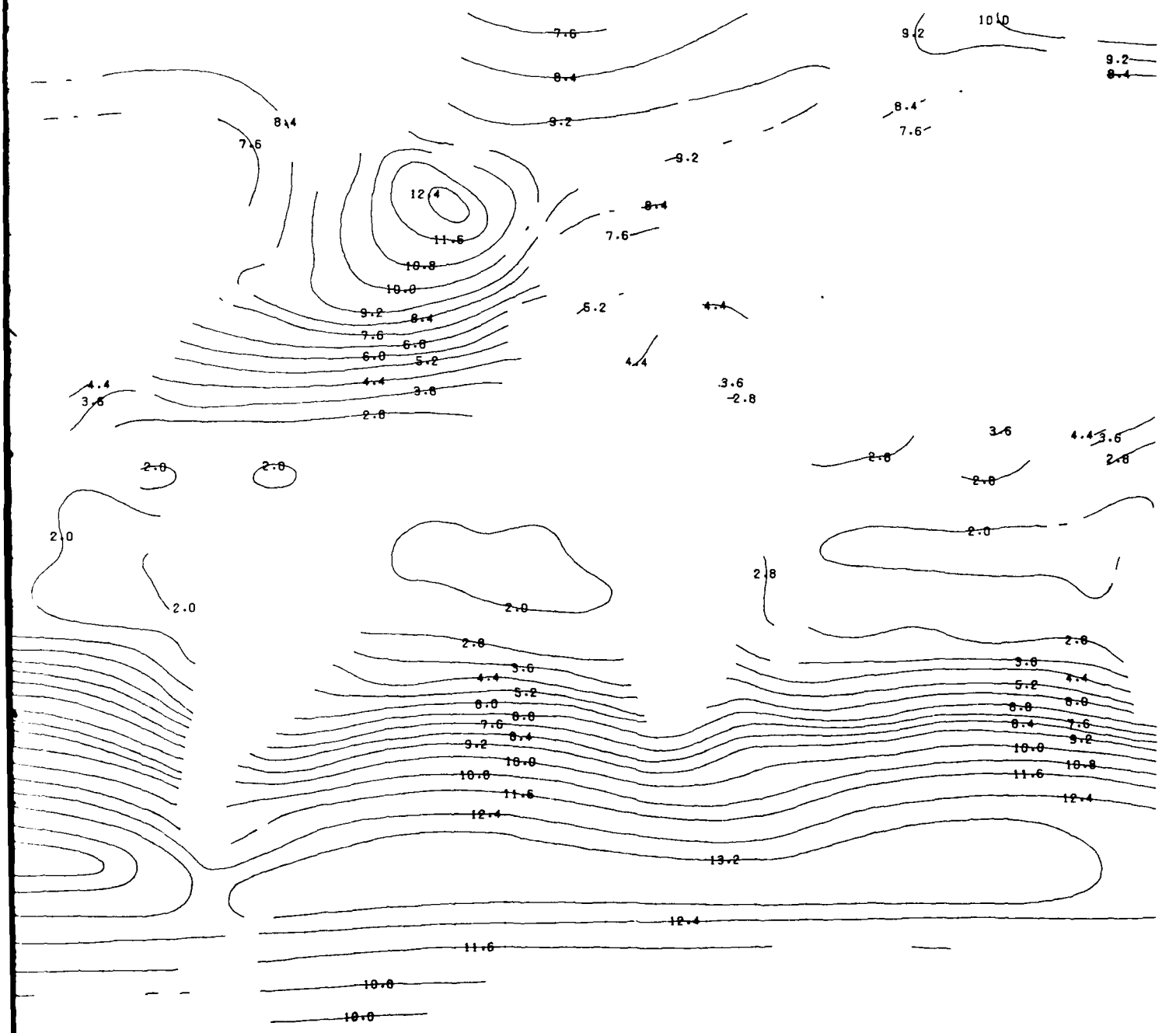

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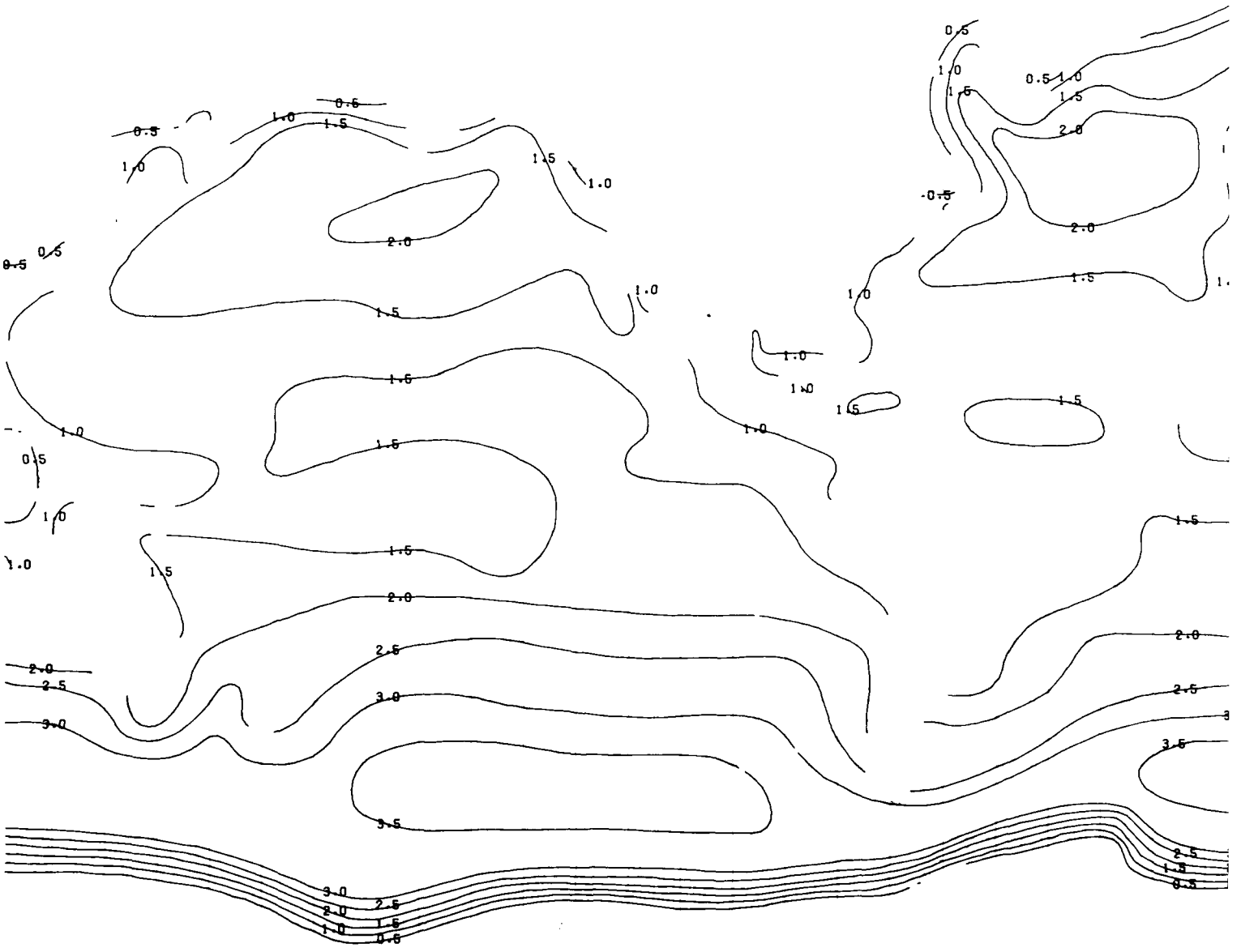
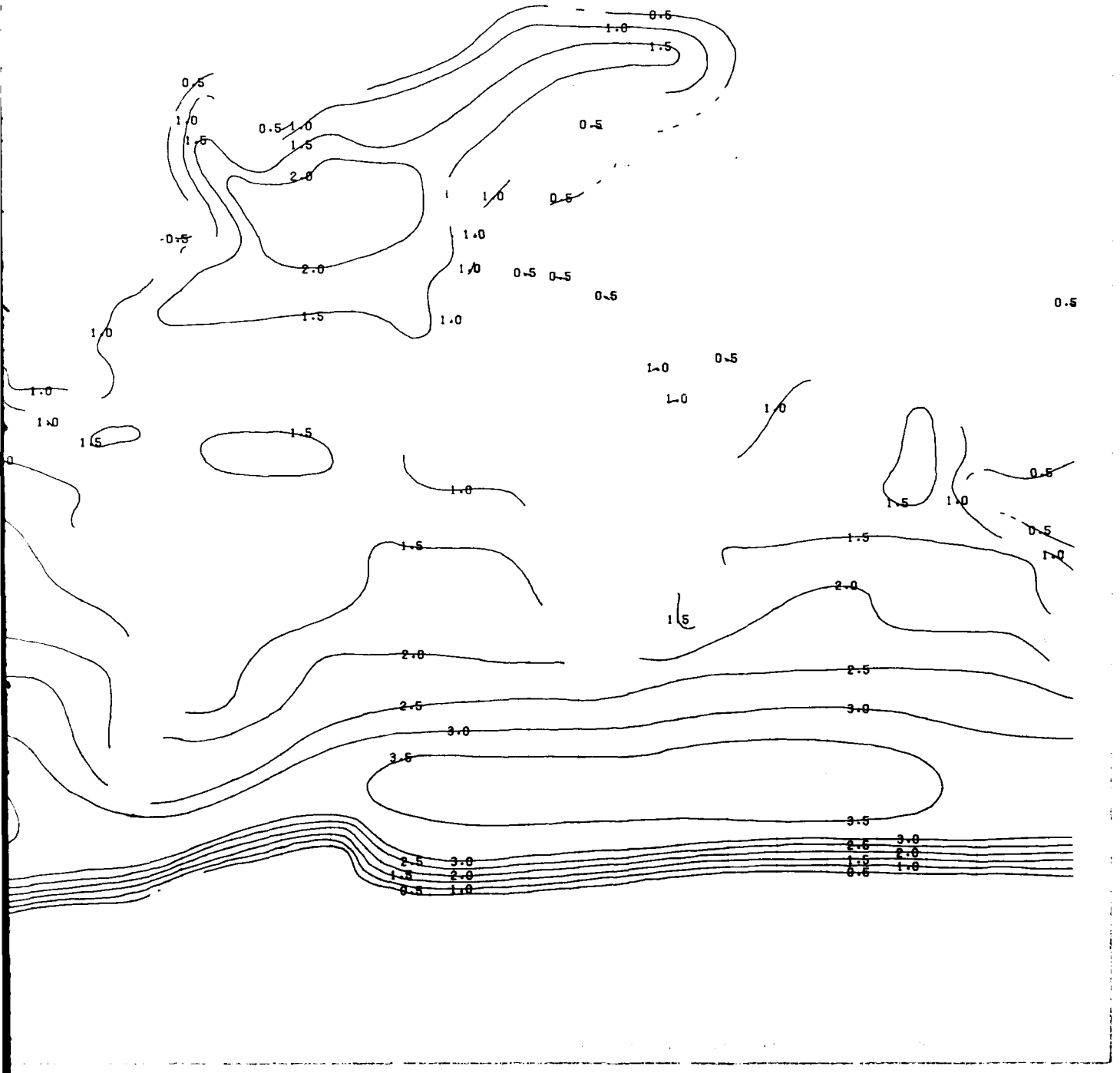
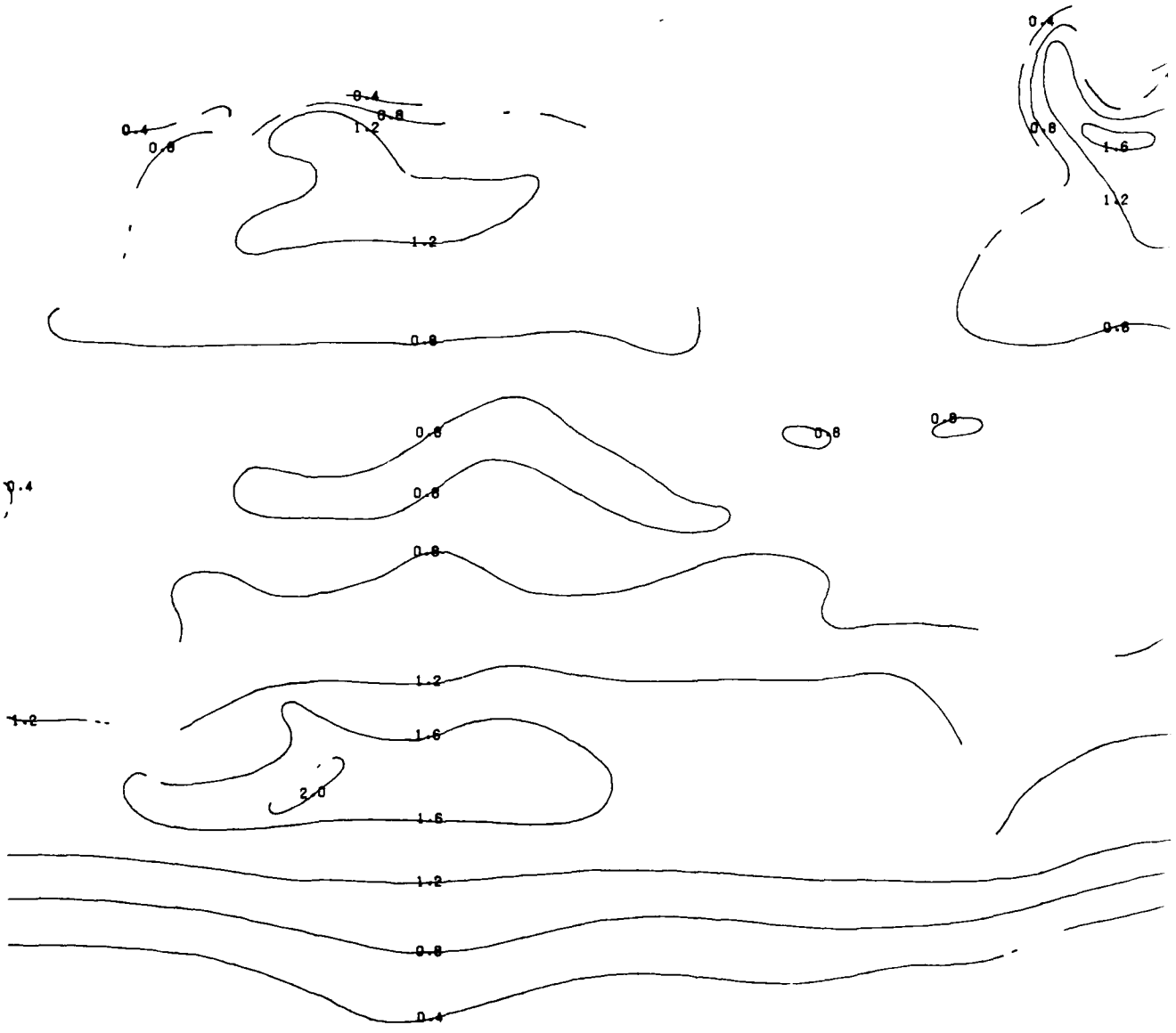


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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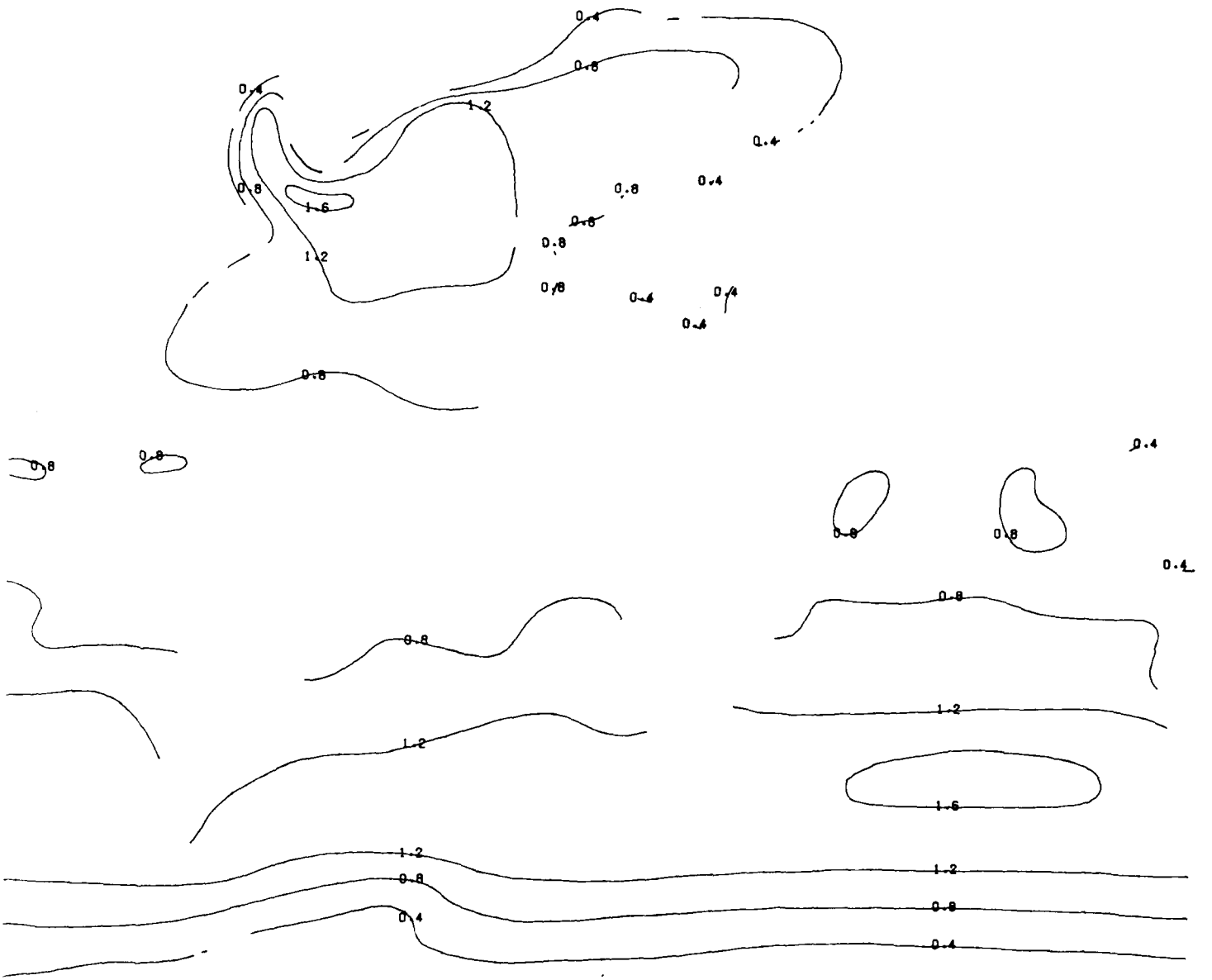
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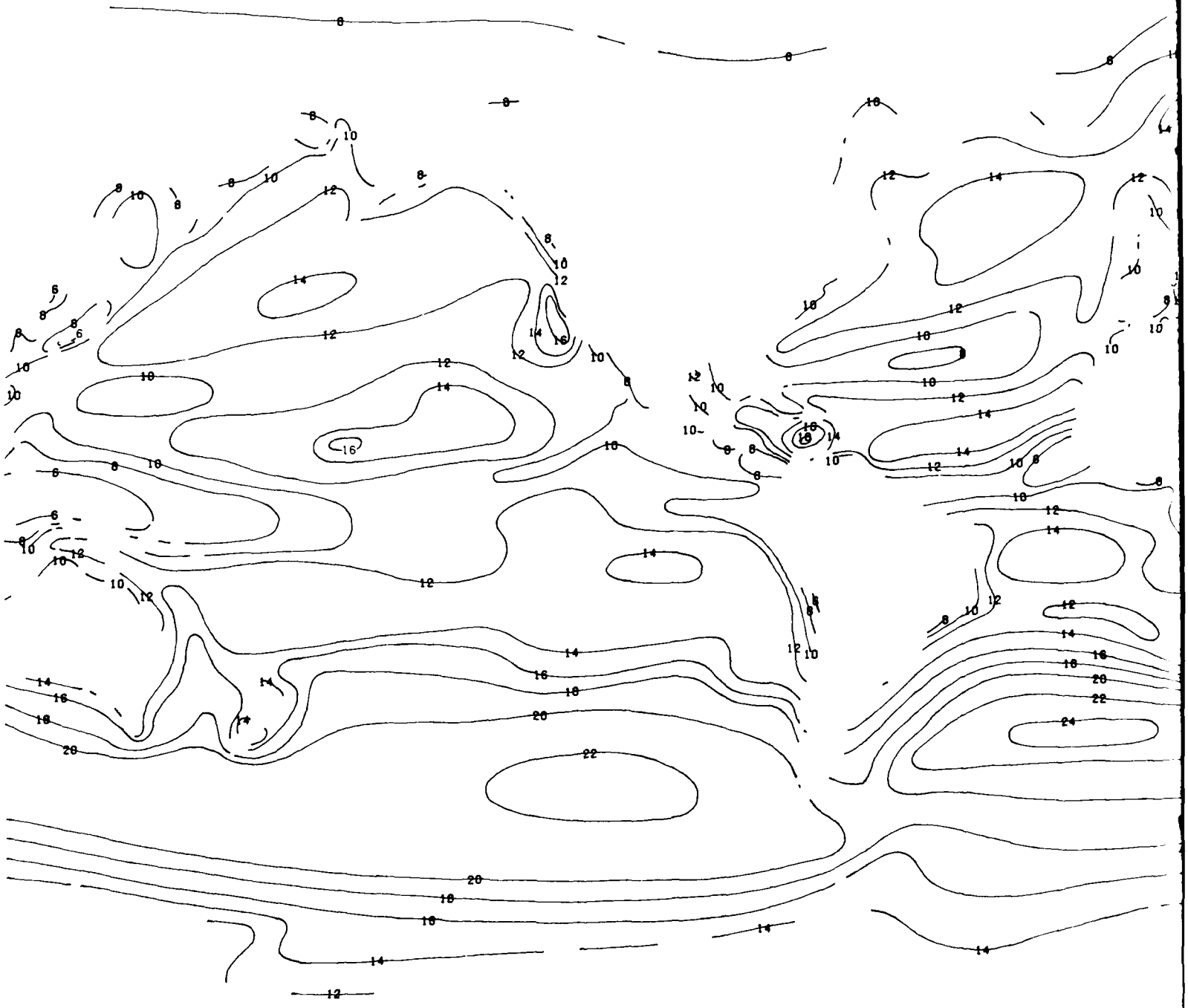
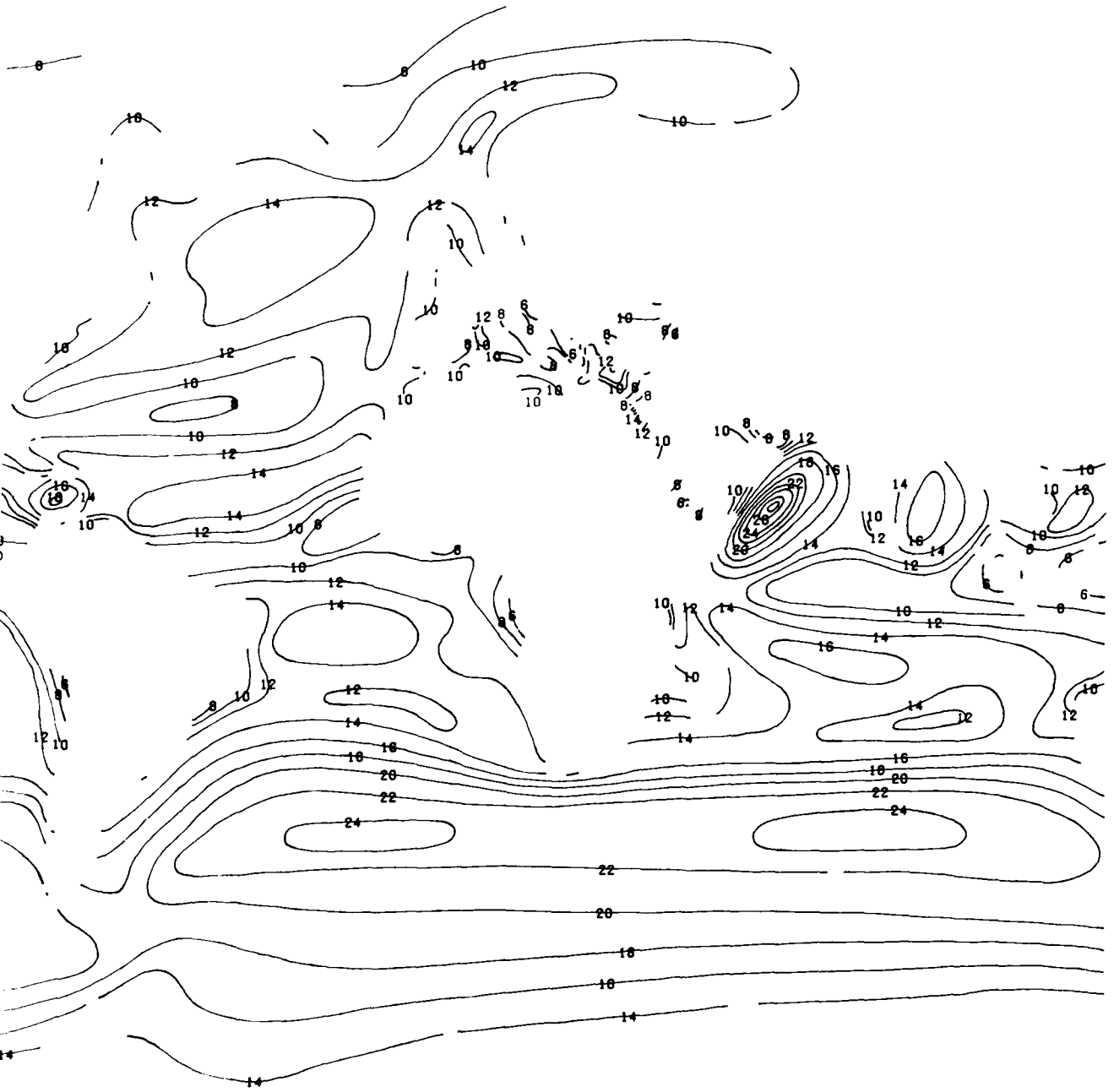


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS

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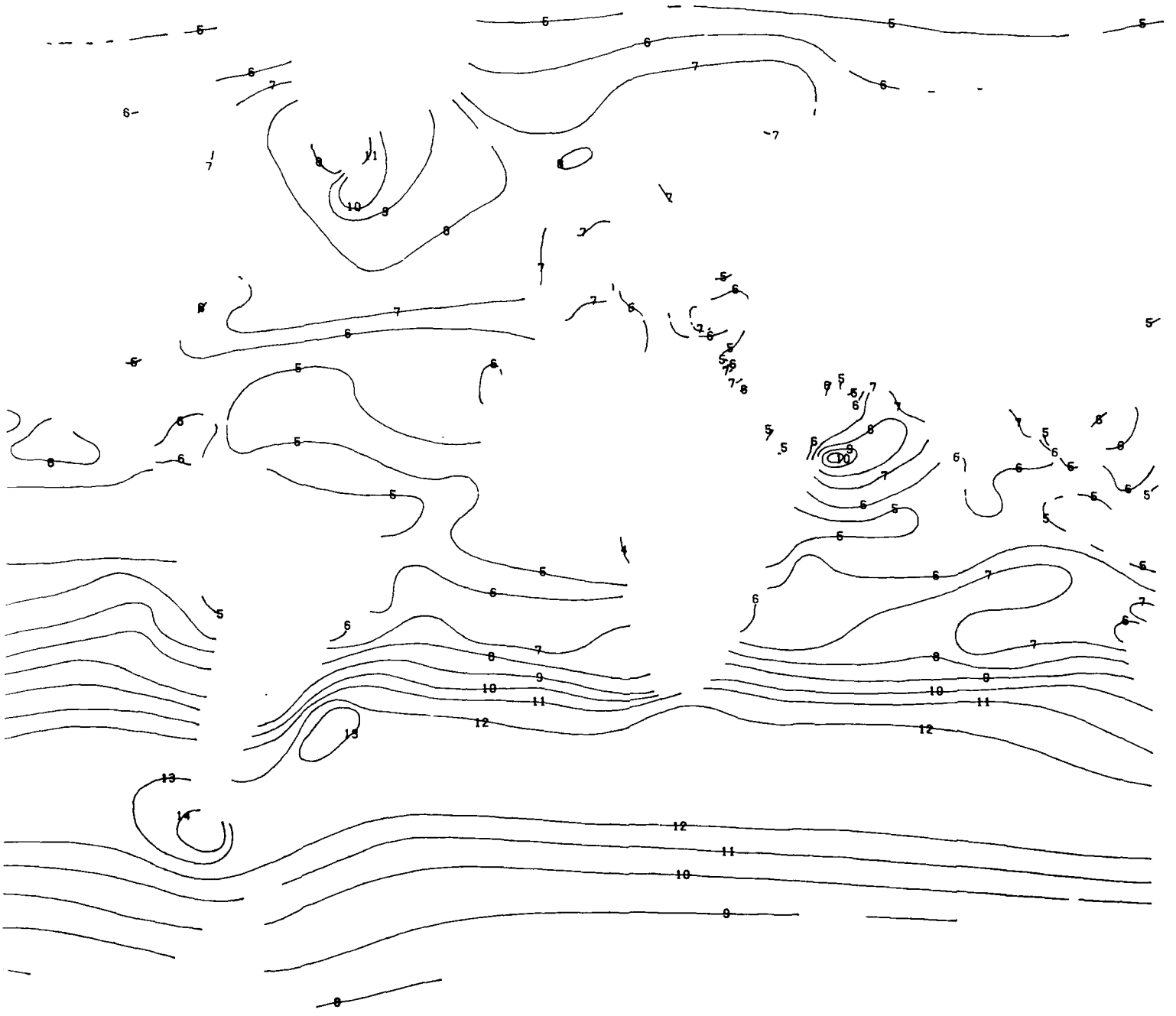

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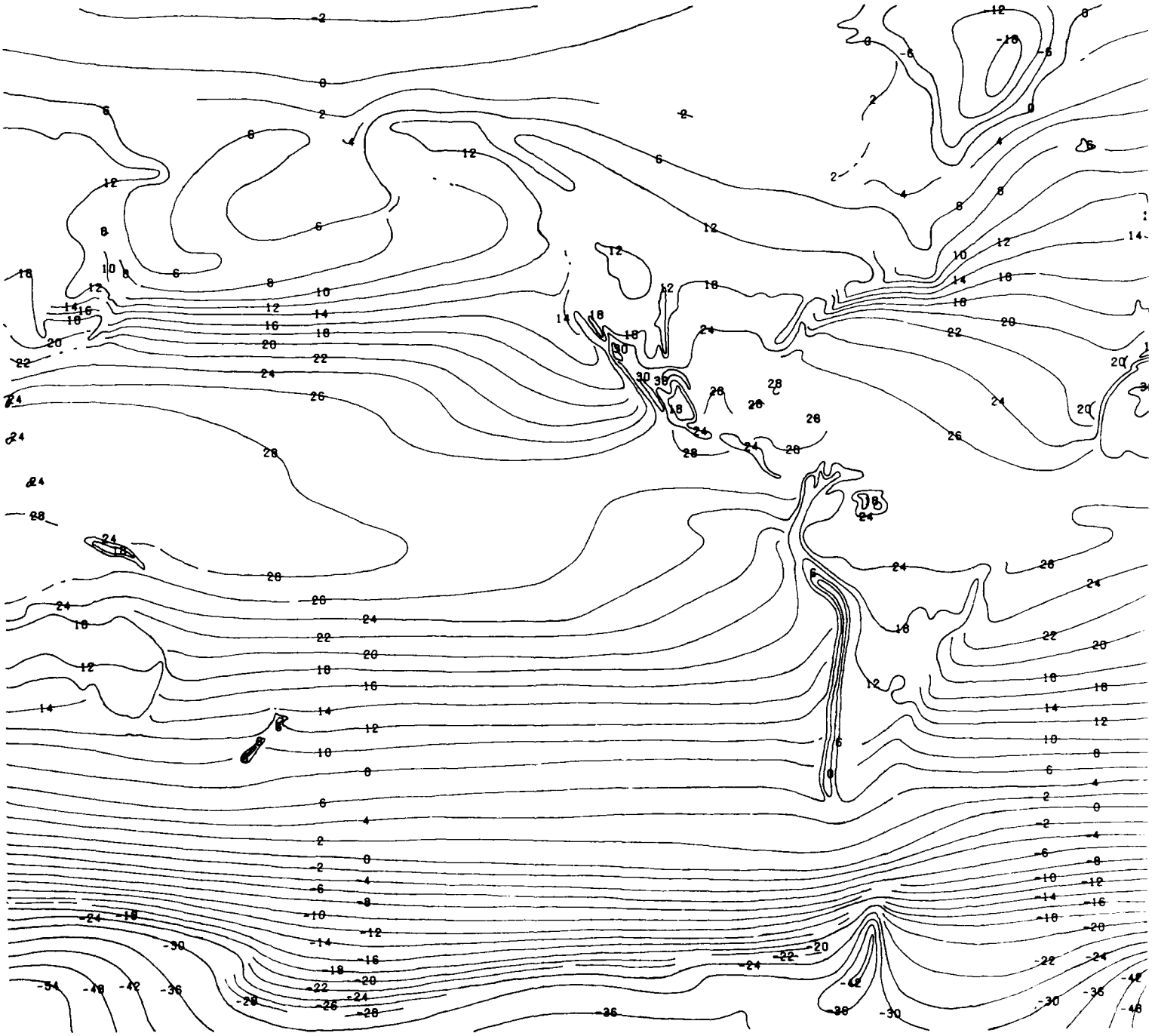
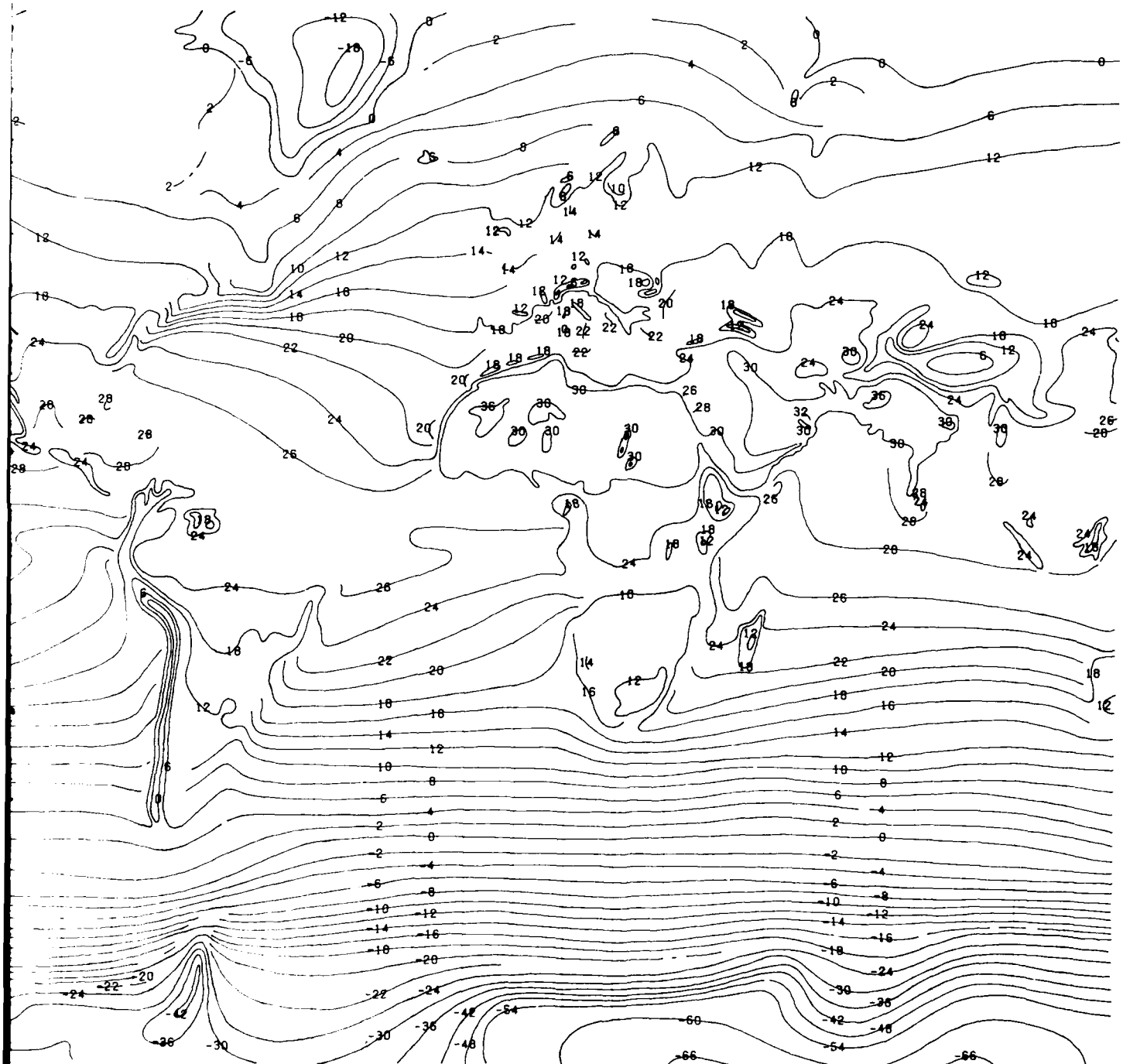
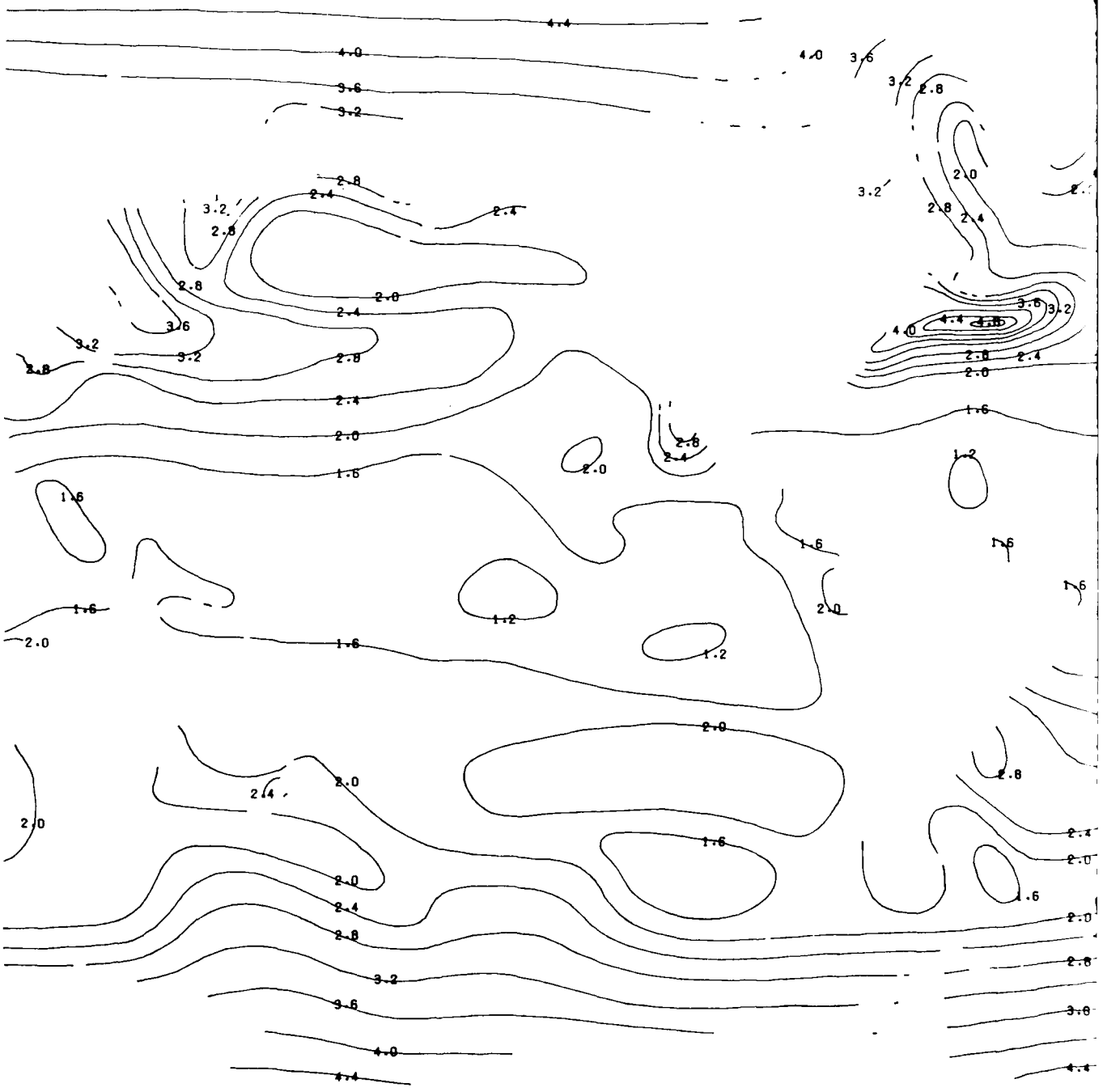


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



DARD DEVIATIONS

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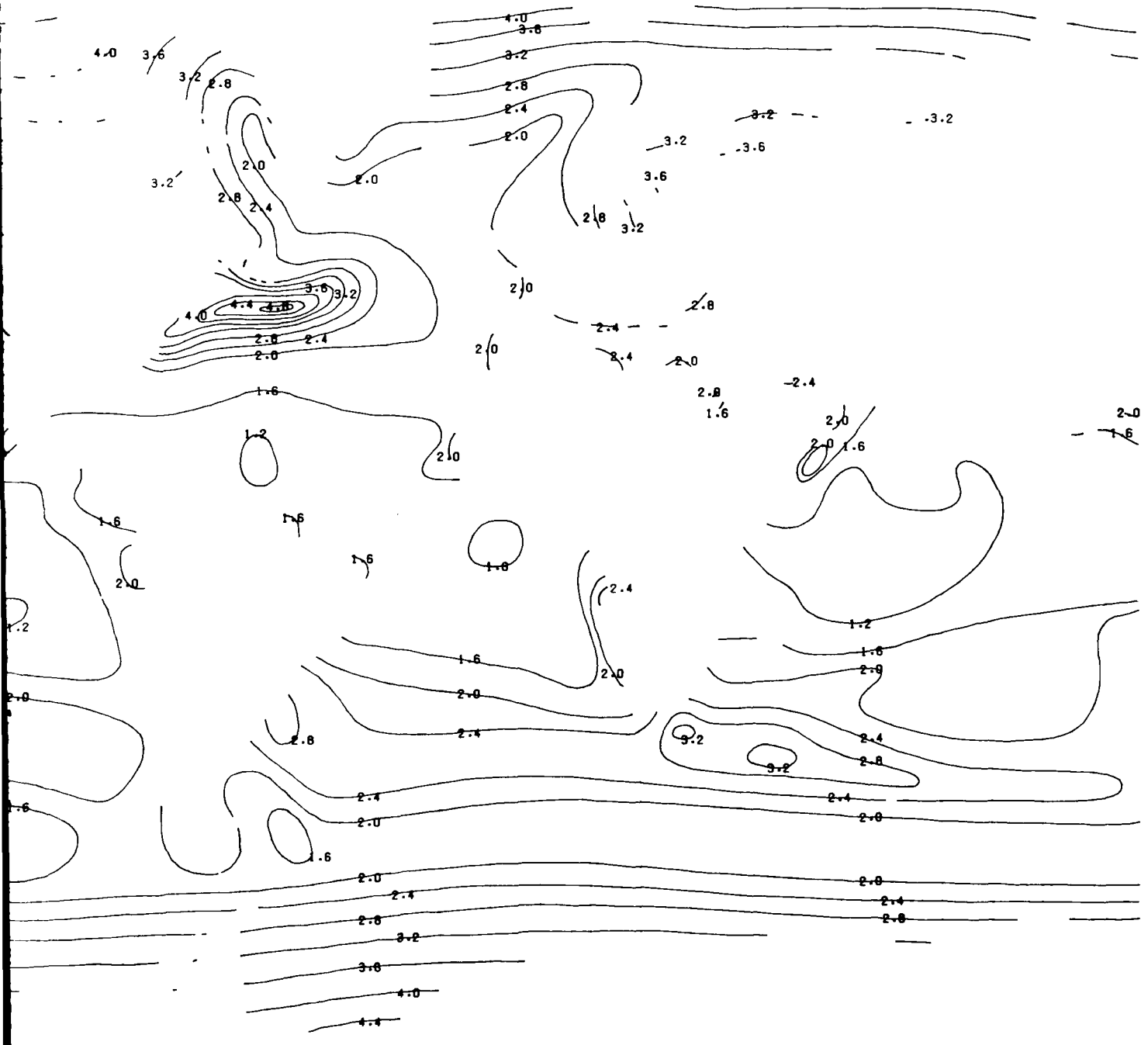

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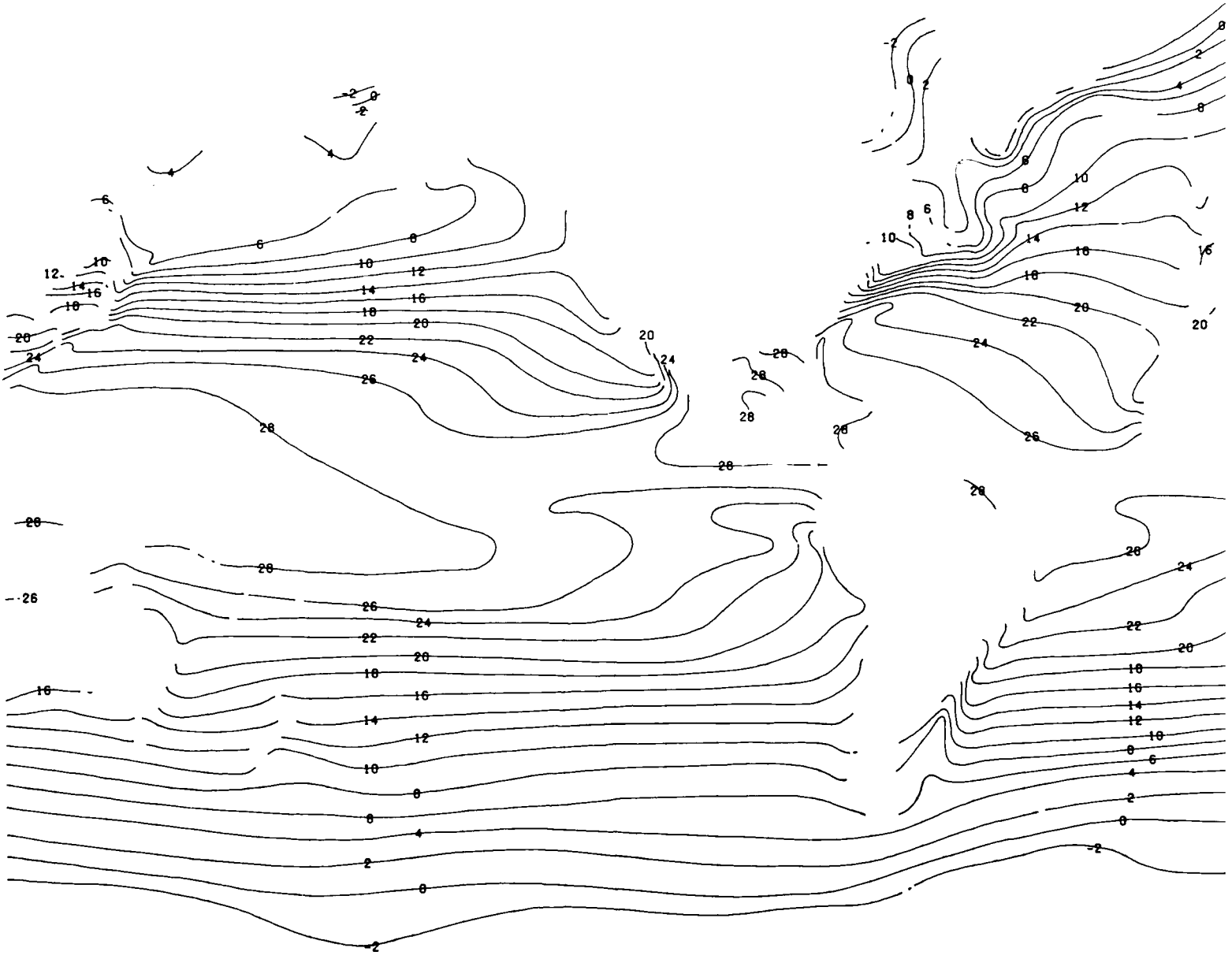
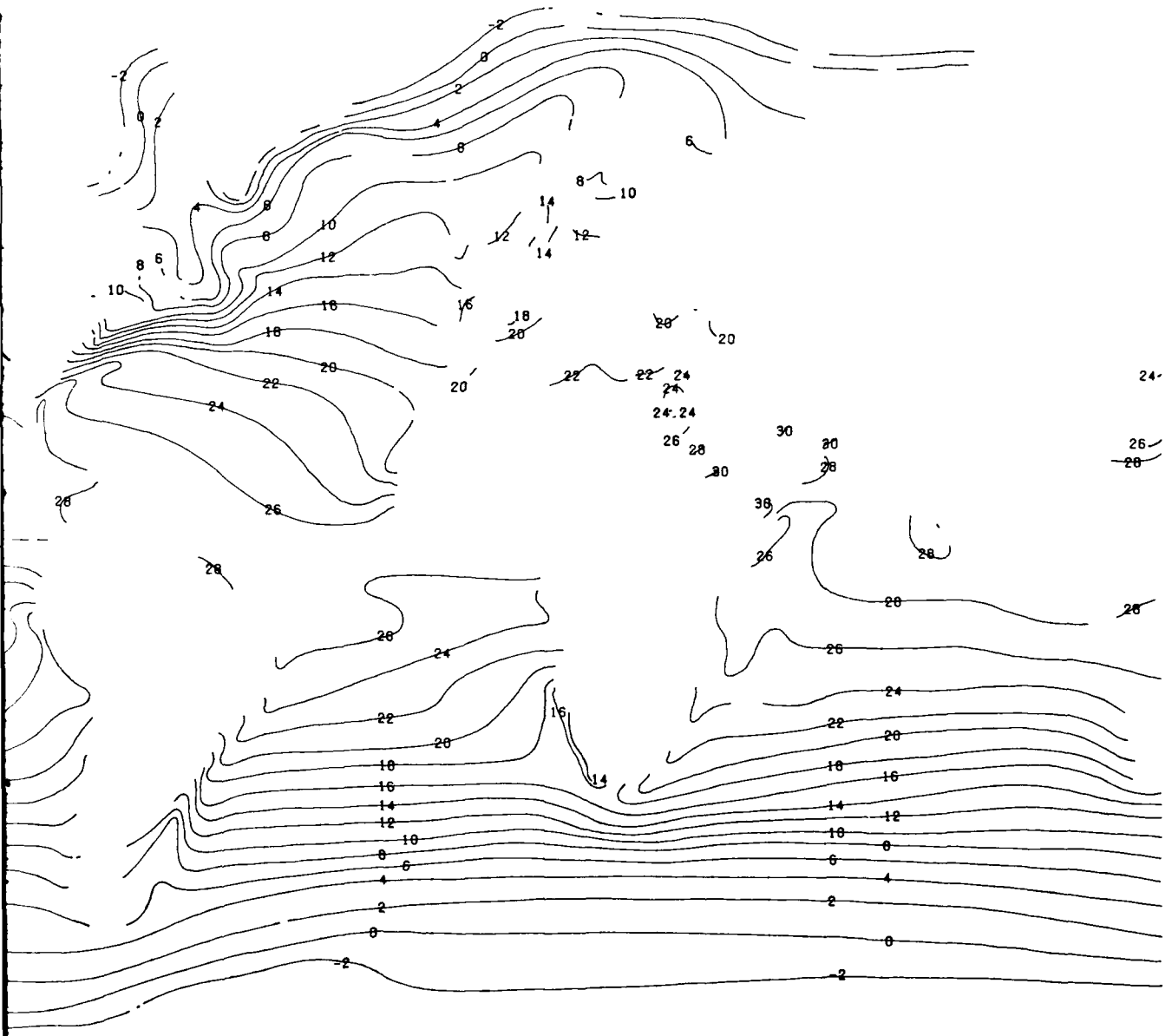
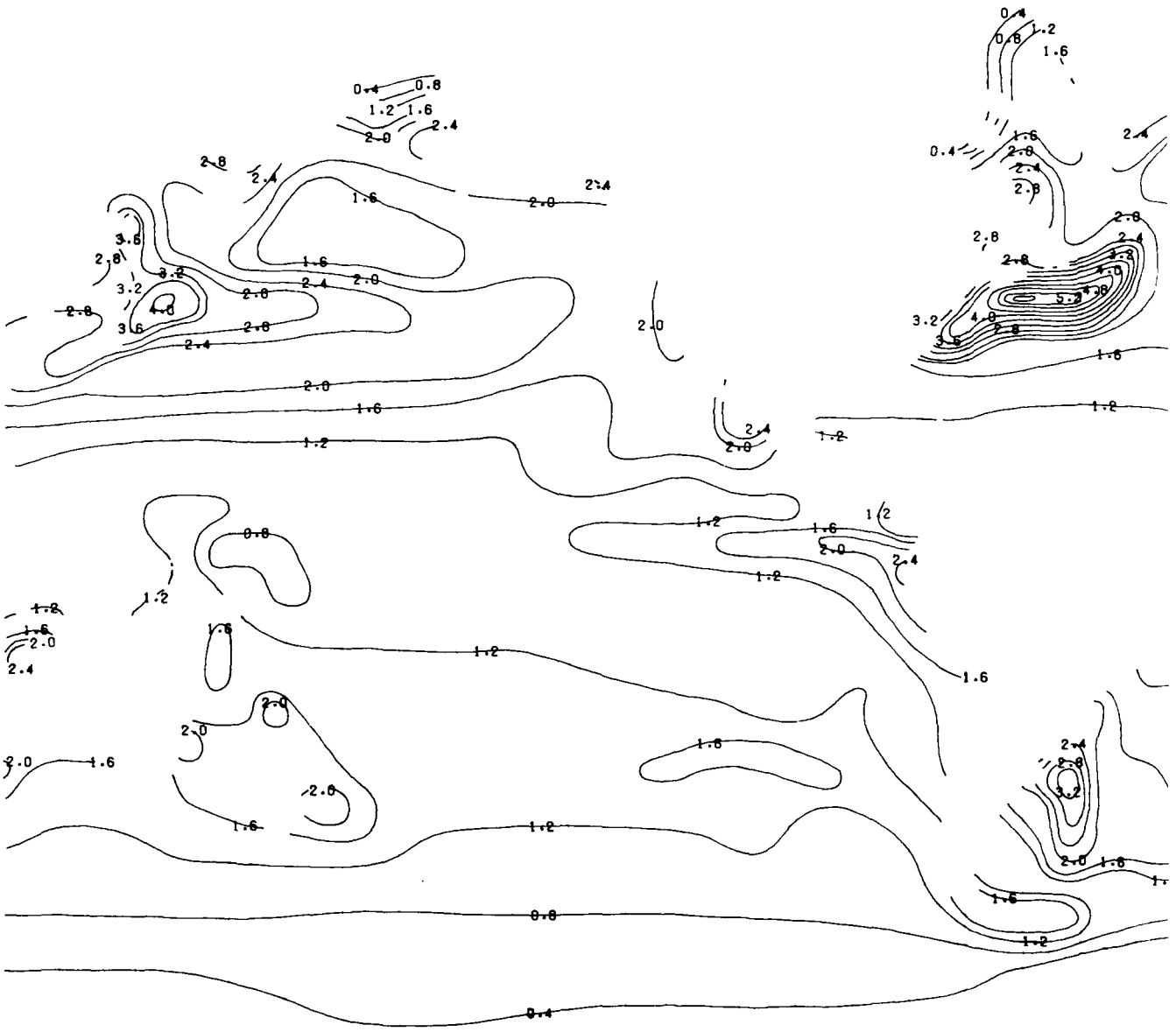
SEA S



SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



NDARD DEVIATIONS

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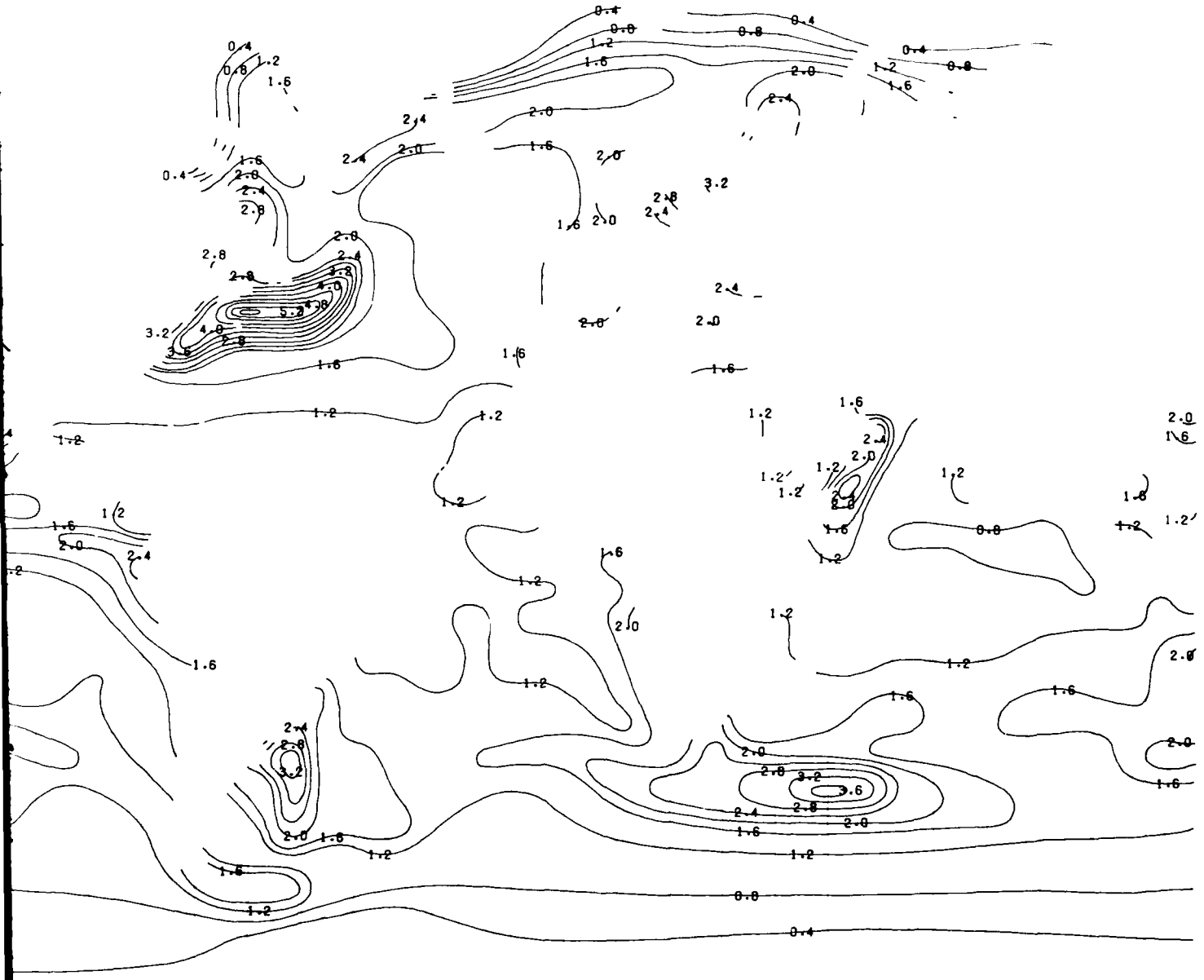

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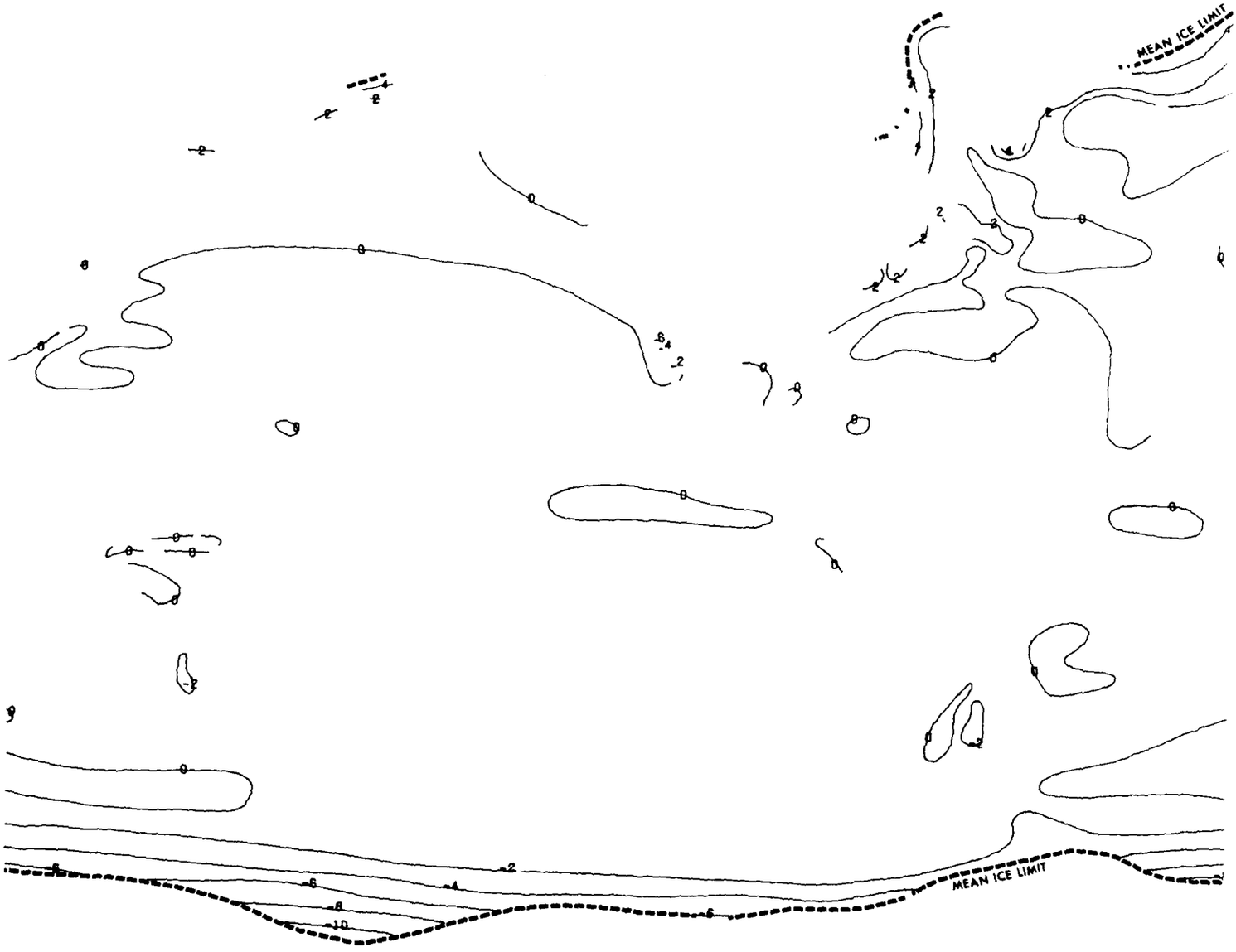
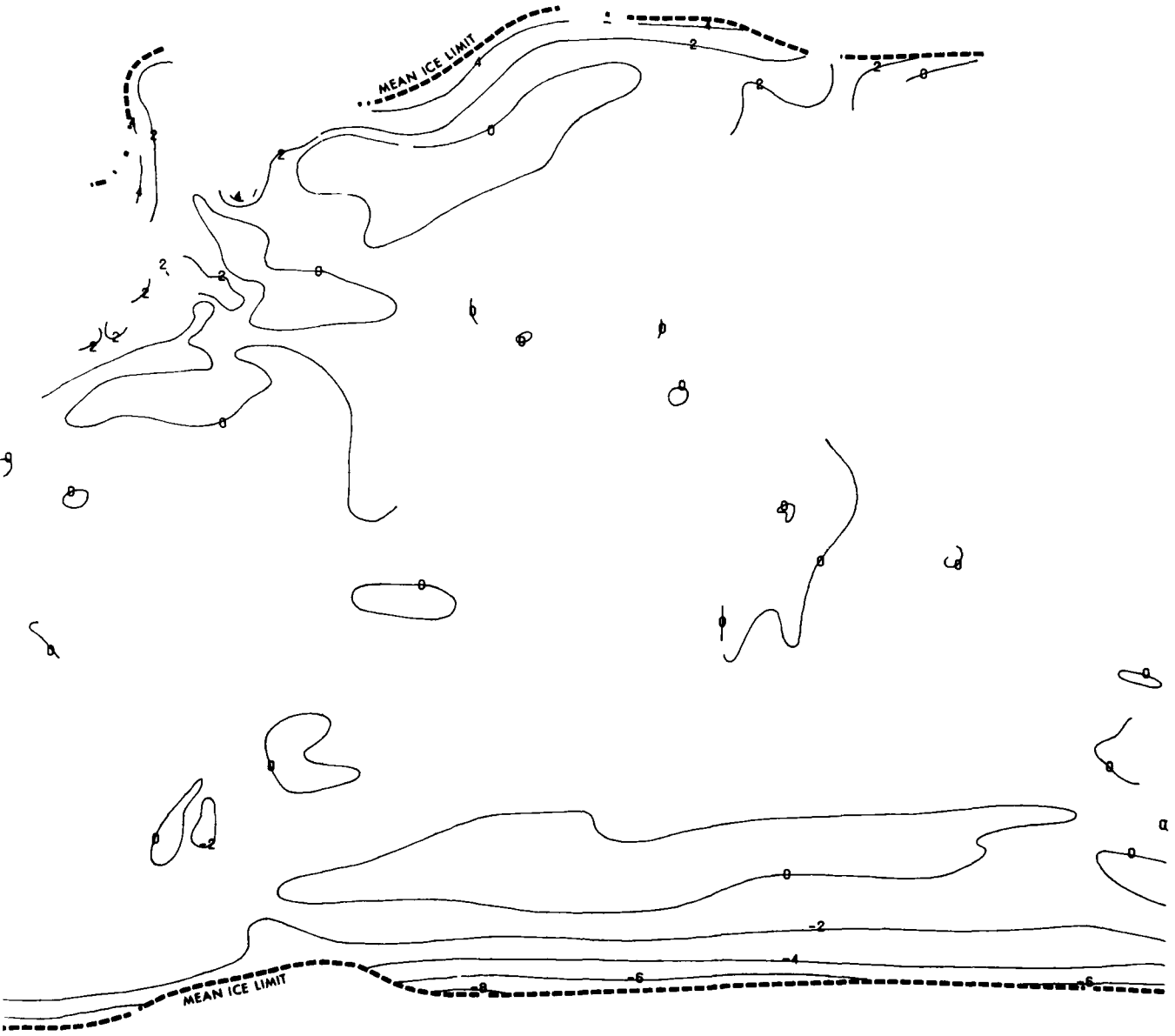
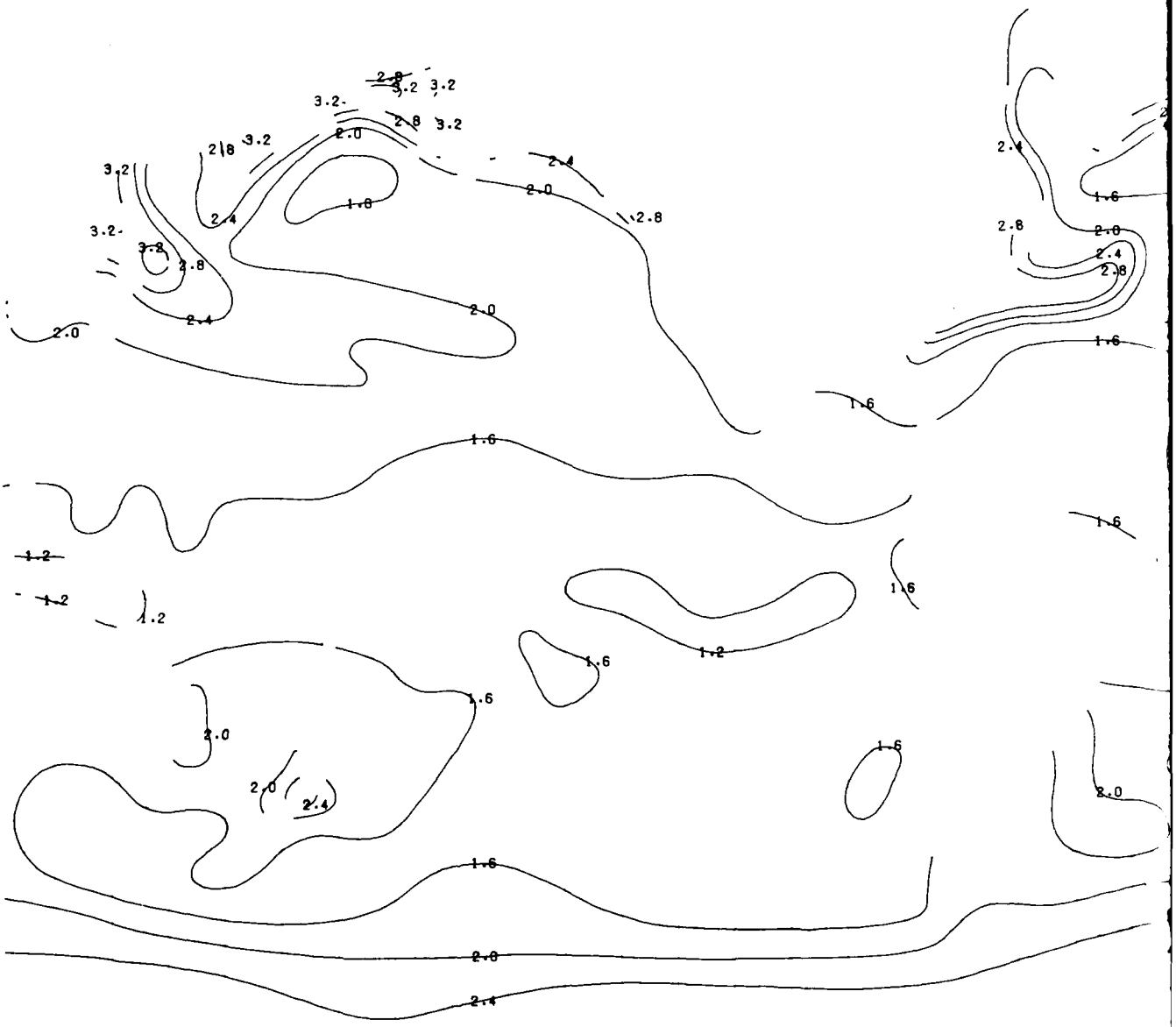
AIR-SEA TEM



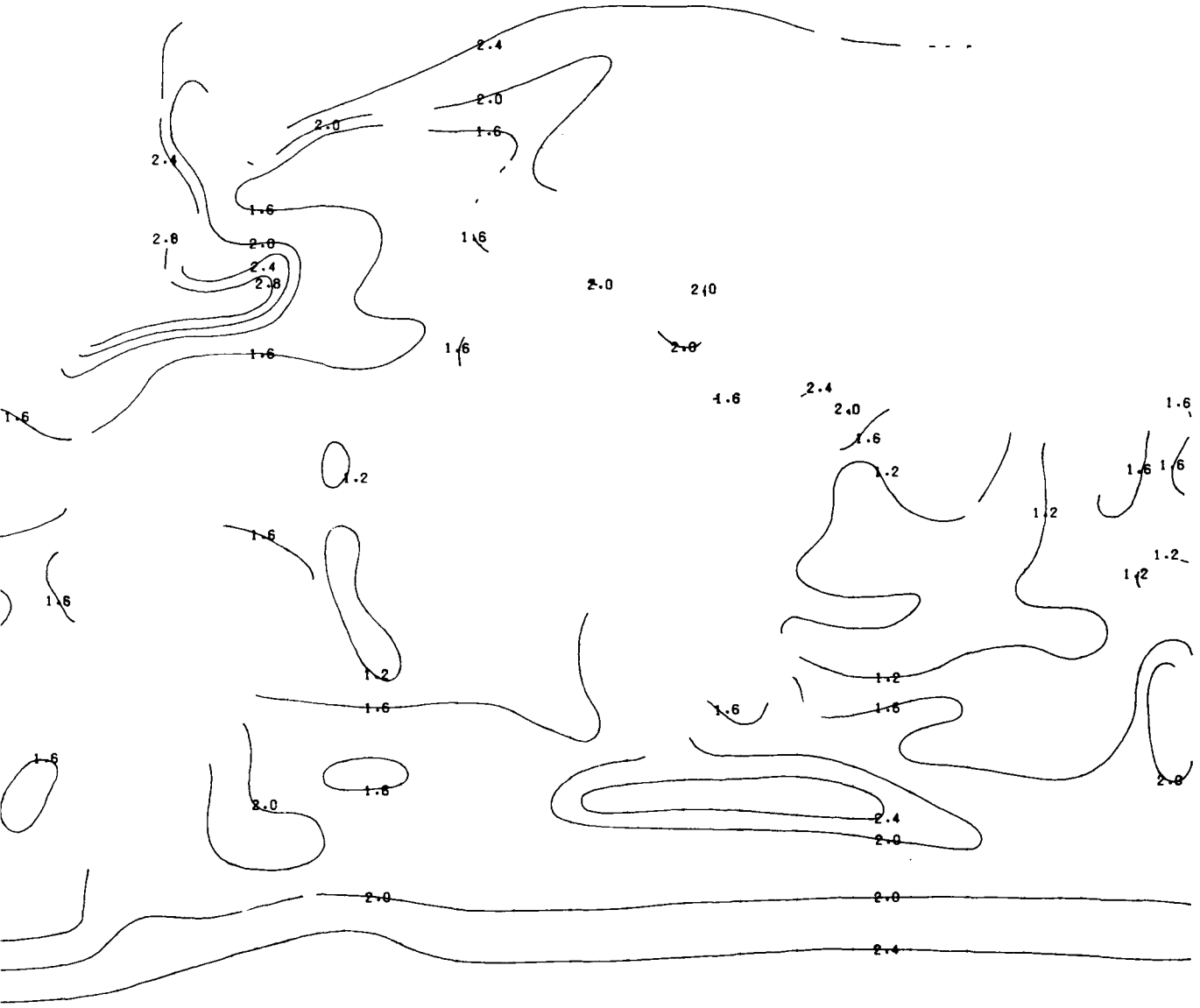
AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS



AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATION



NDARD DEVIATIONS JUNE



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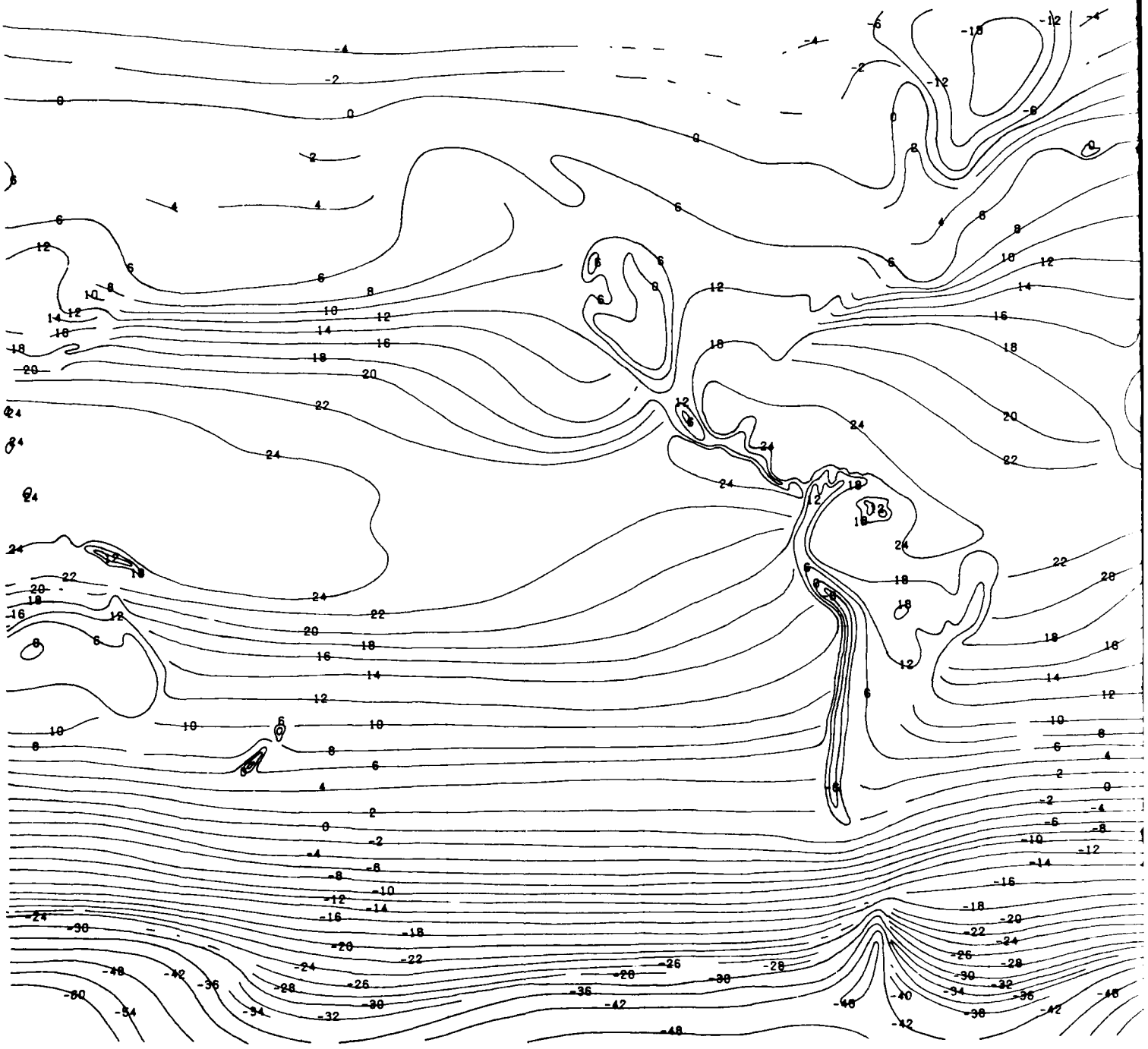
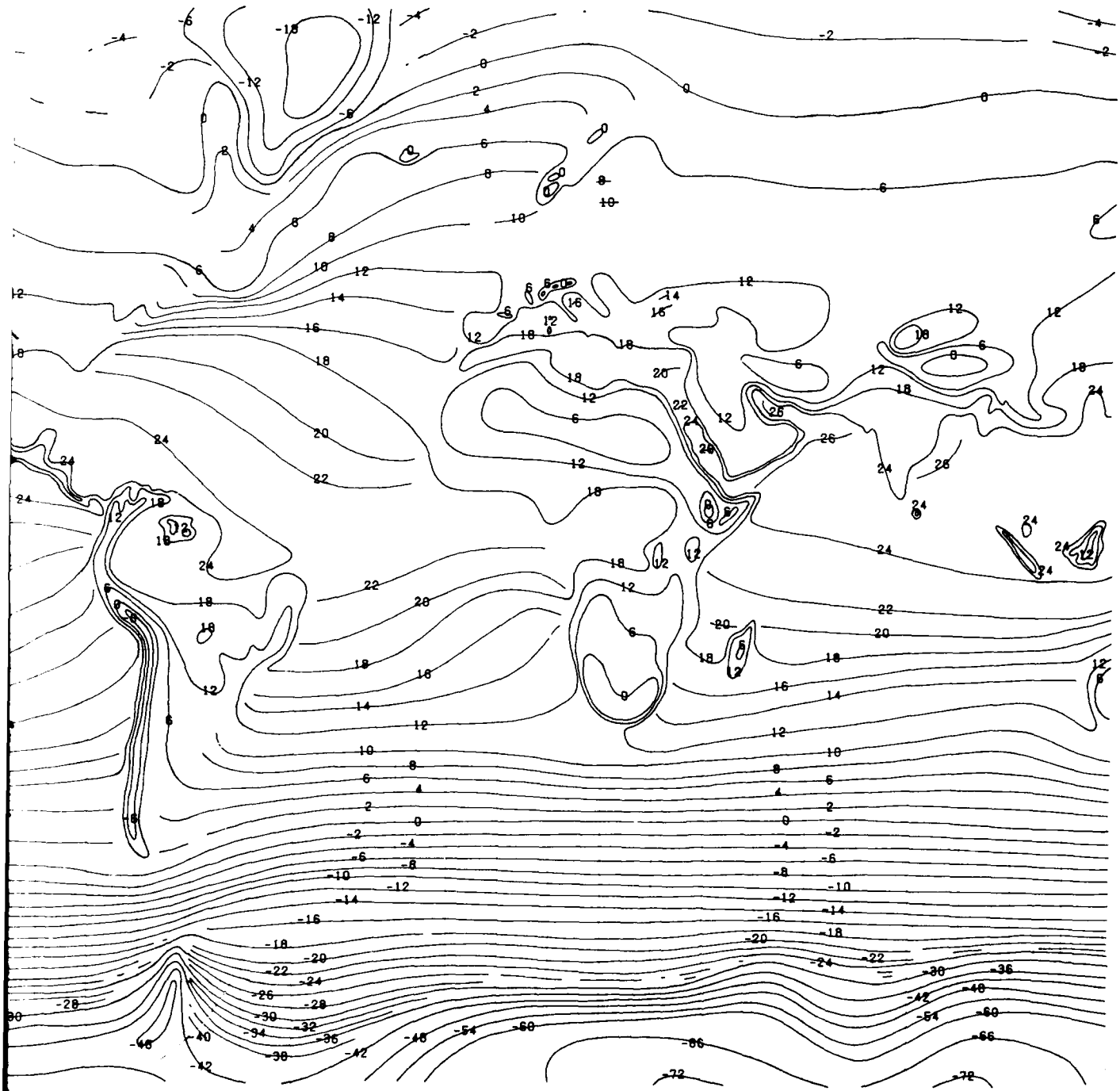
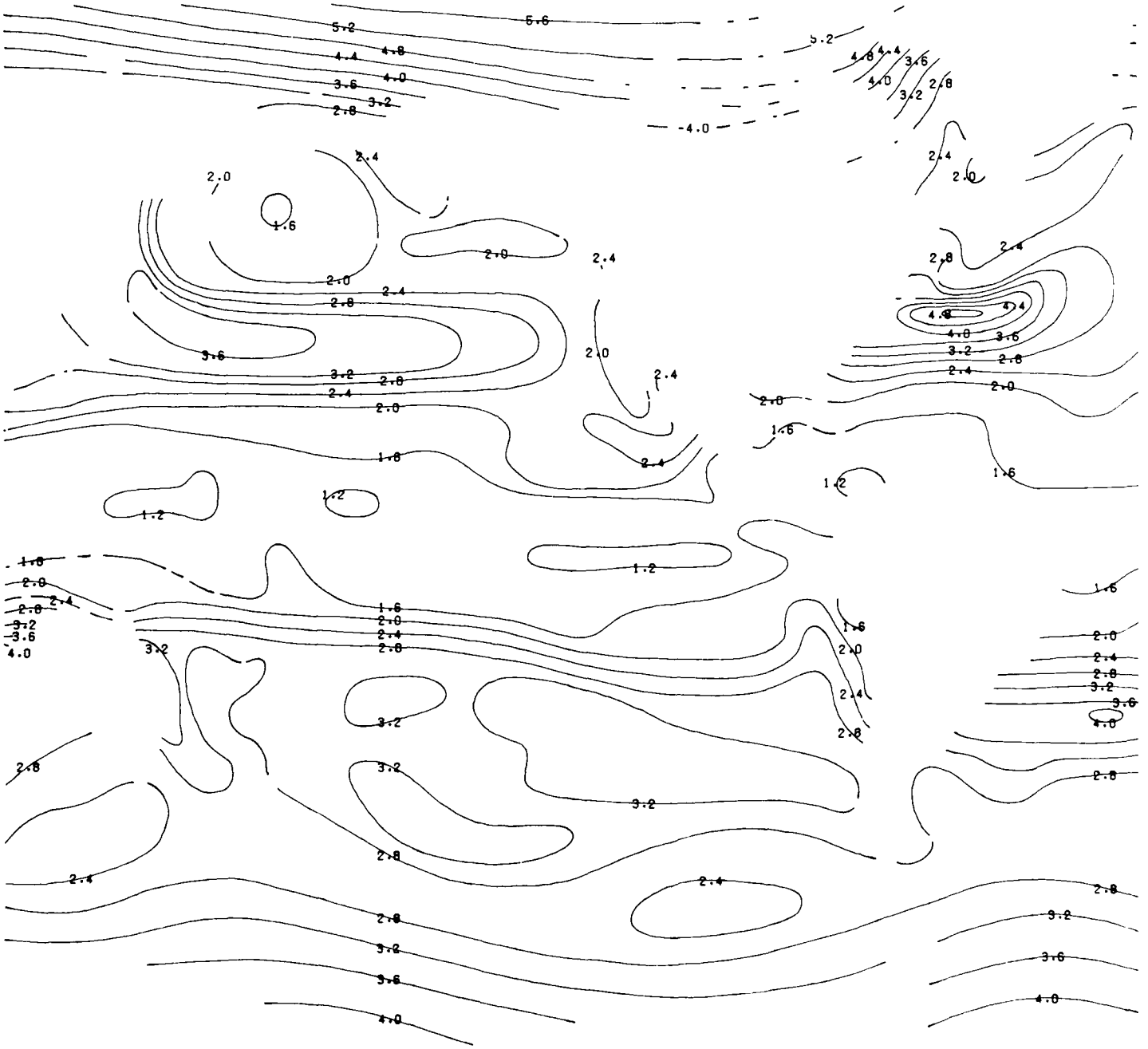


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



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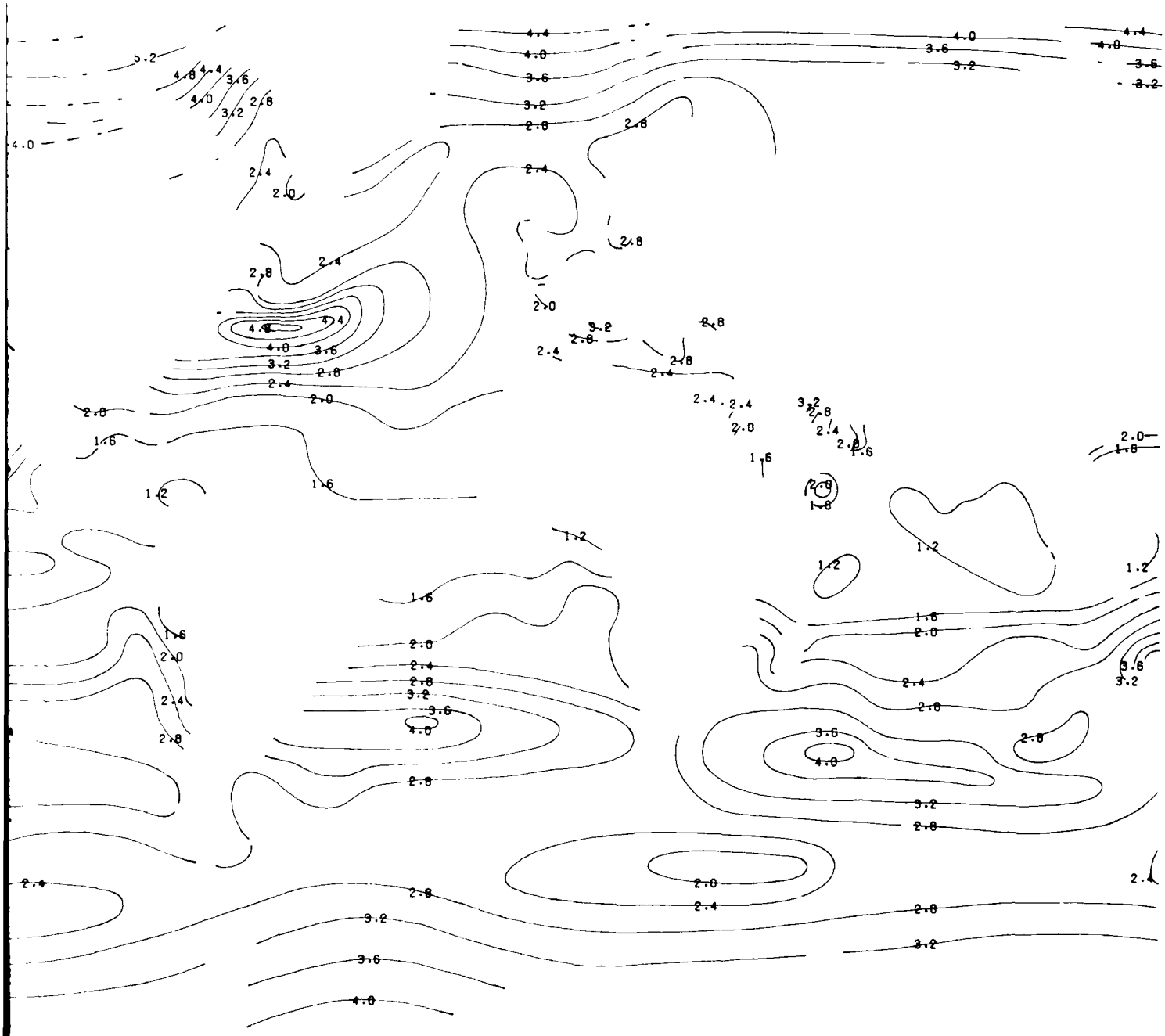

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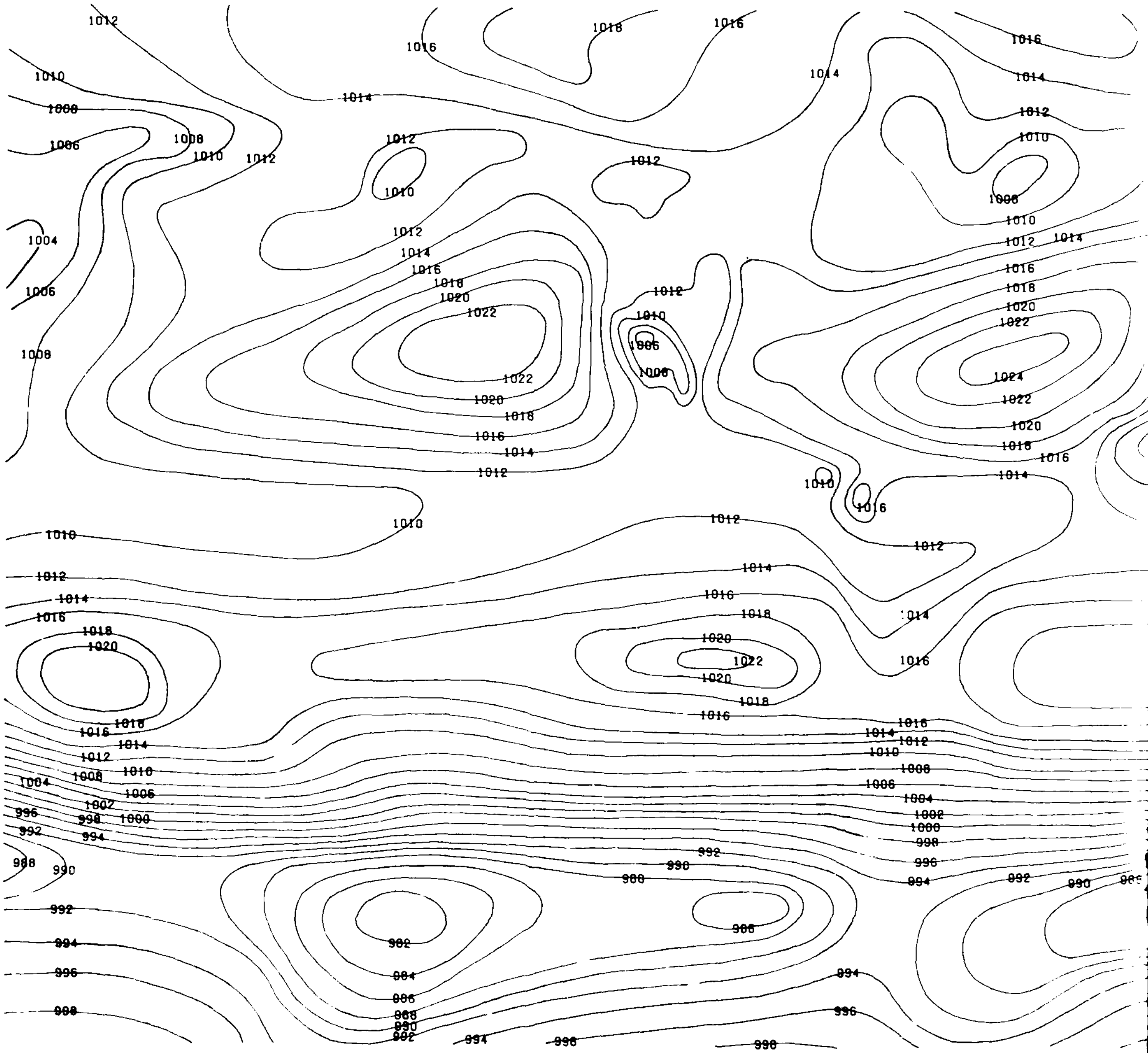
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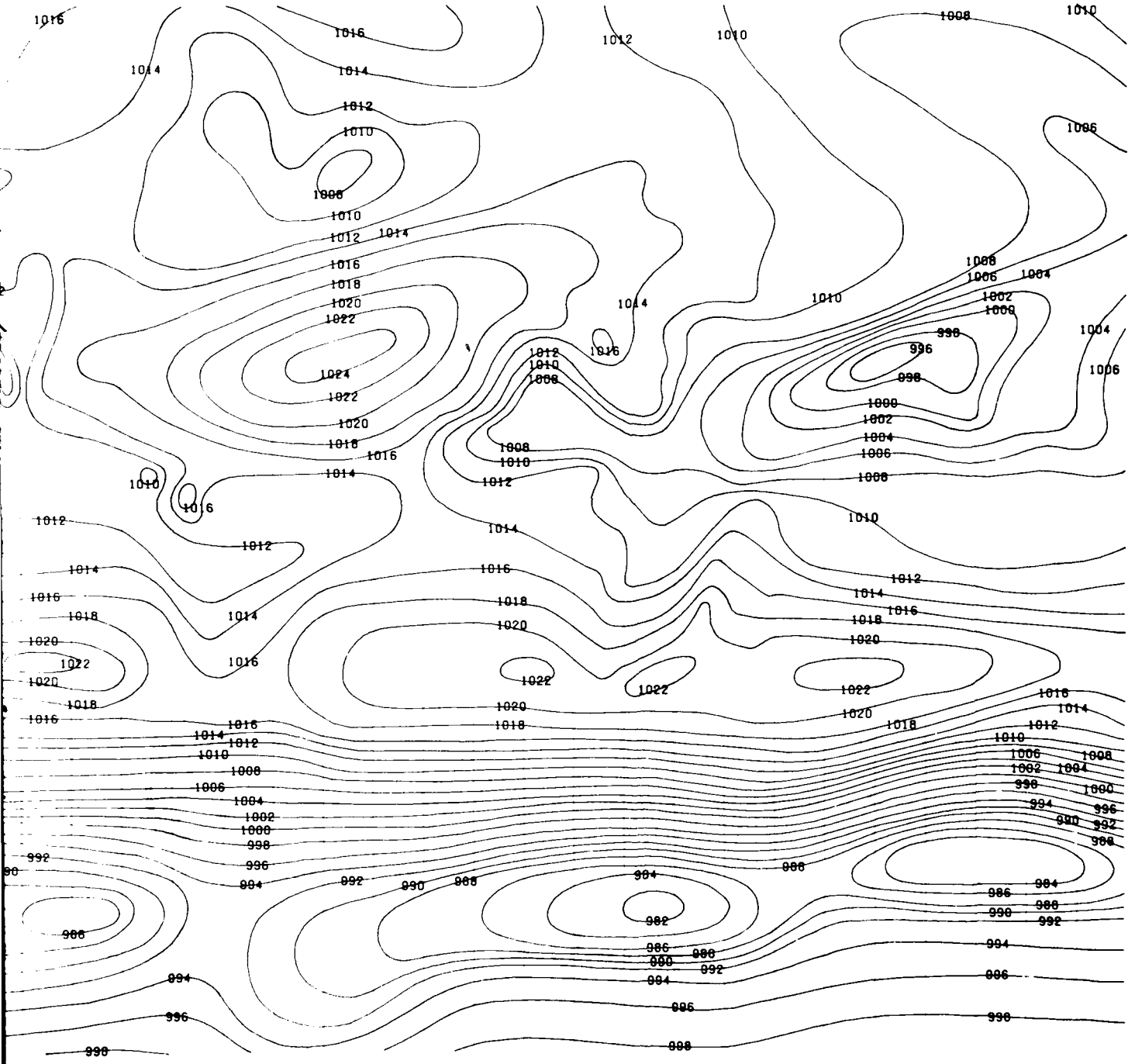
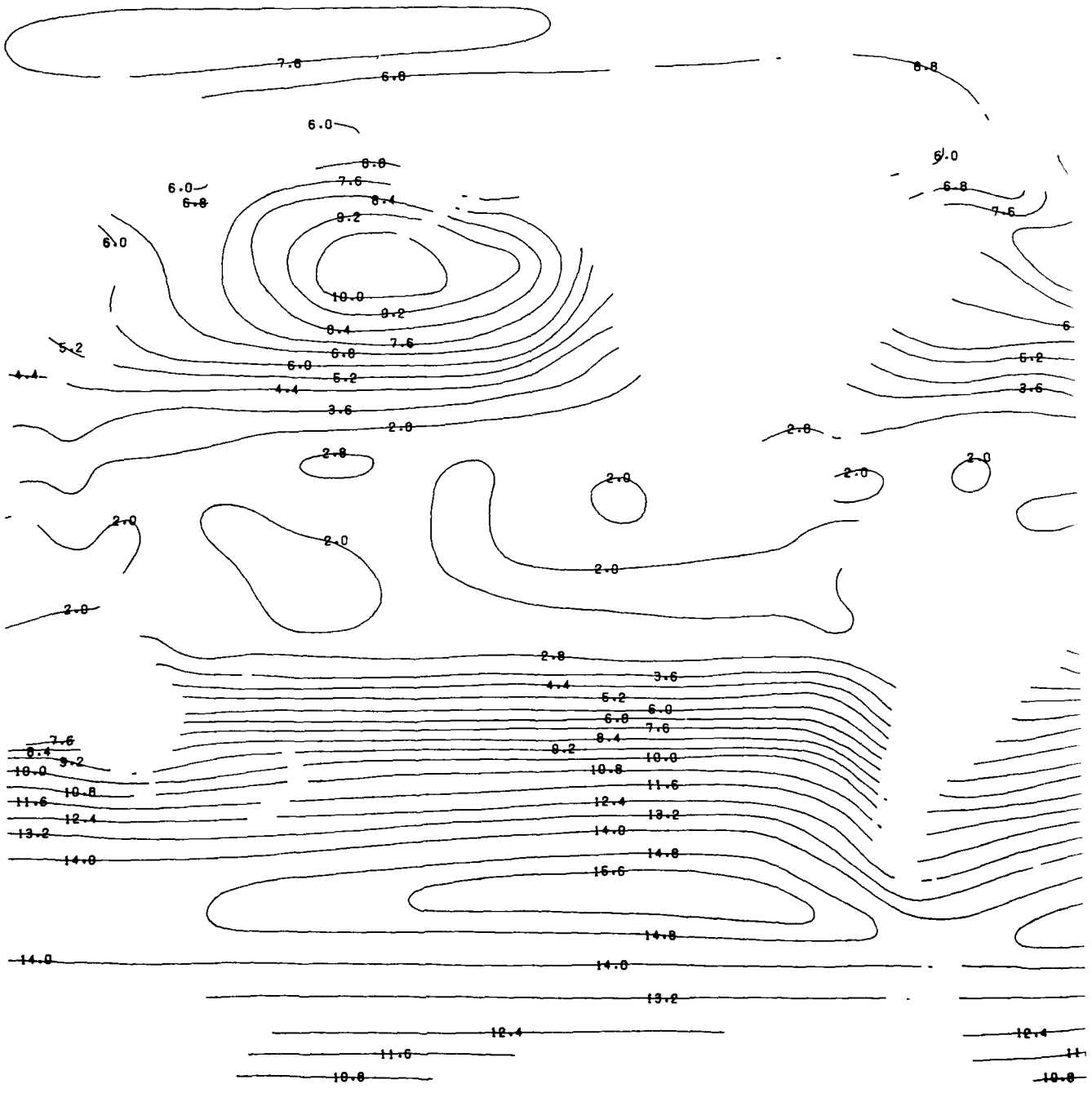
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



) DEVIATIONS

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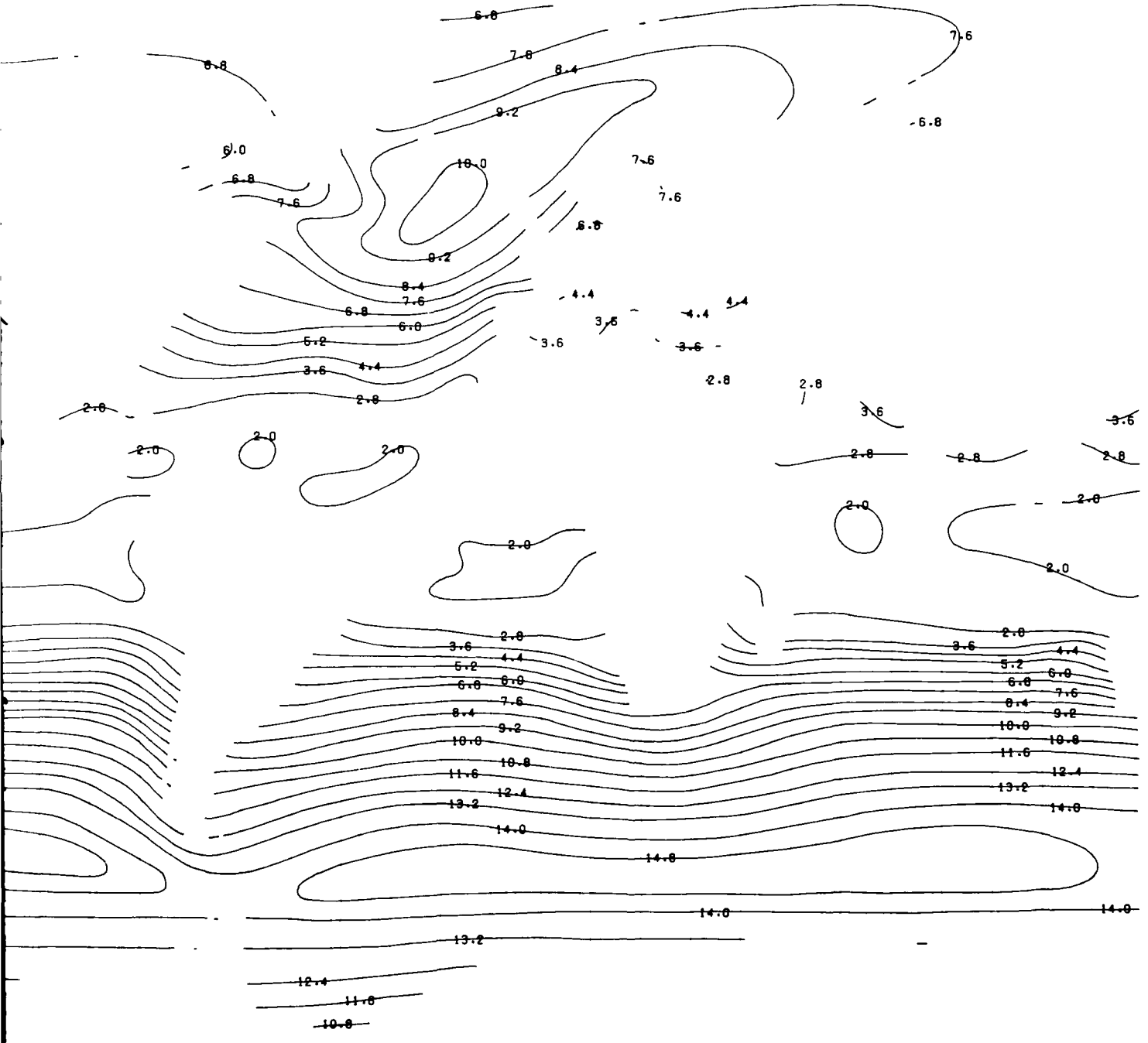

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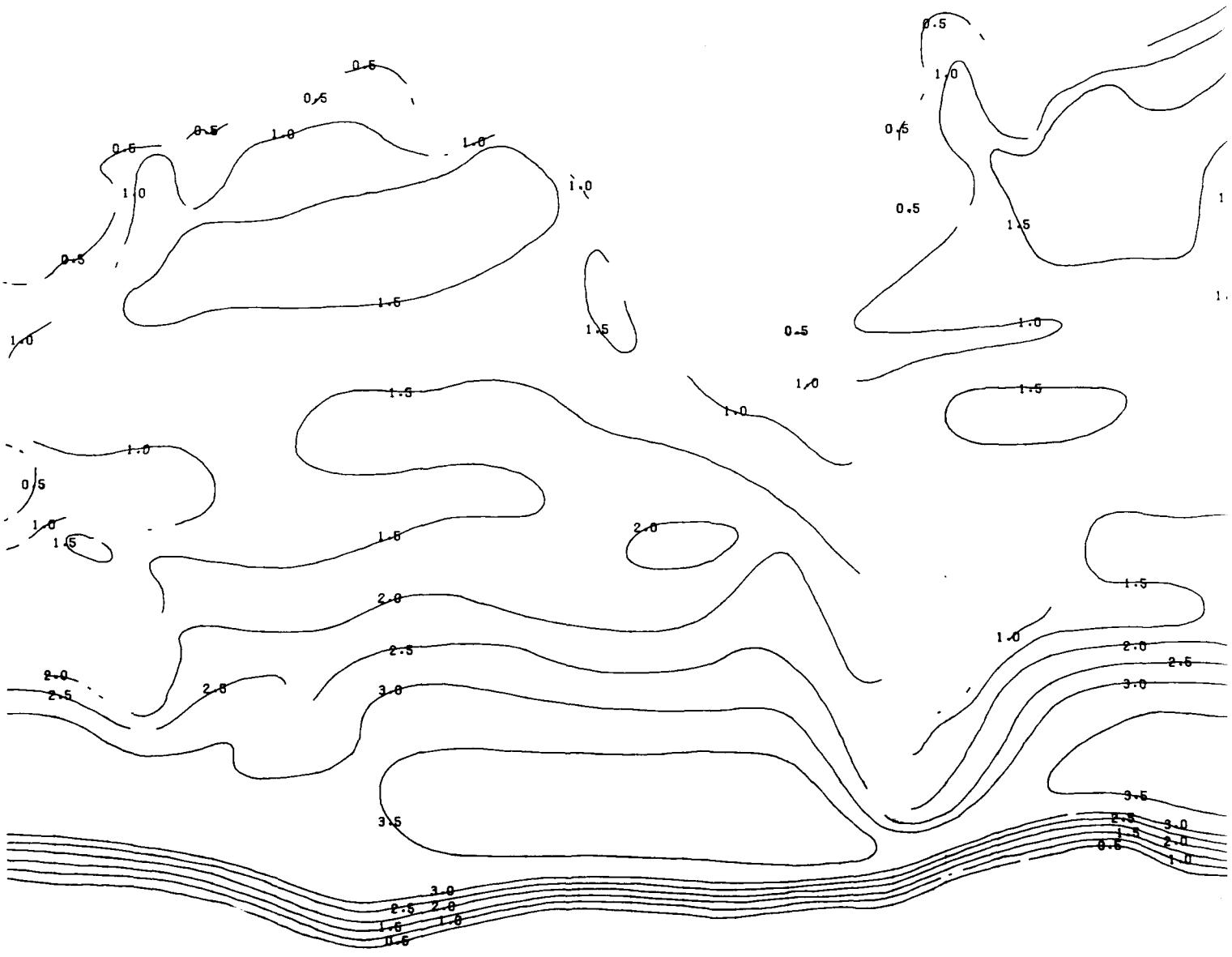
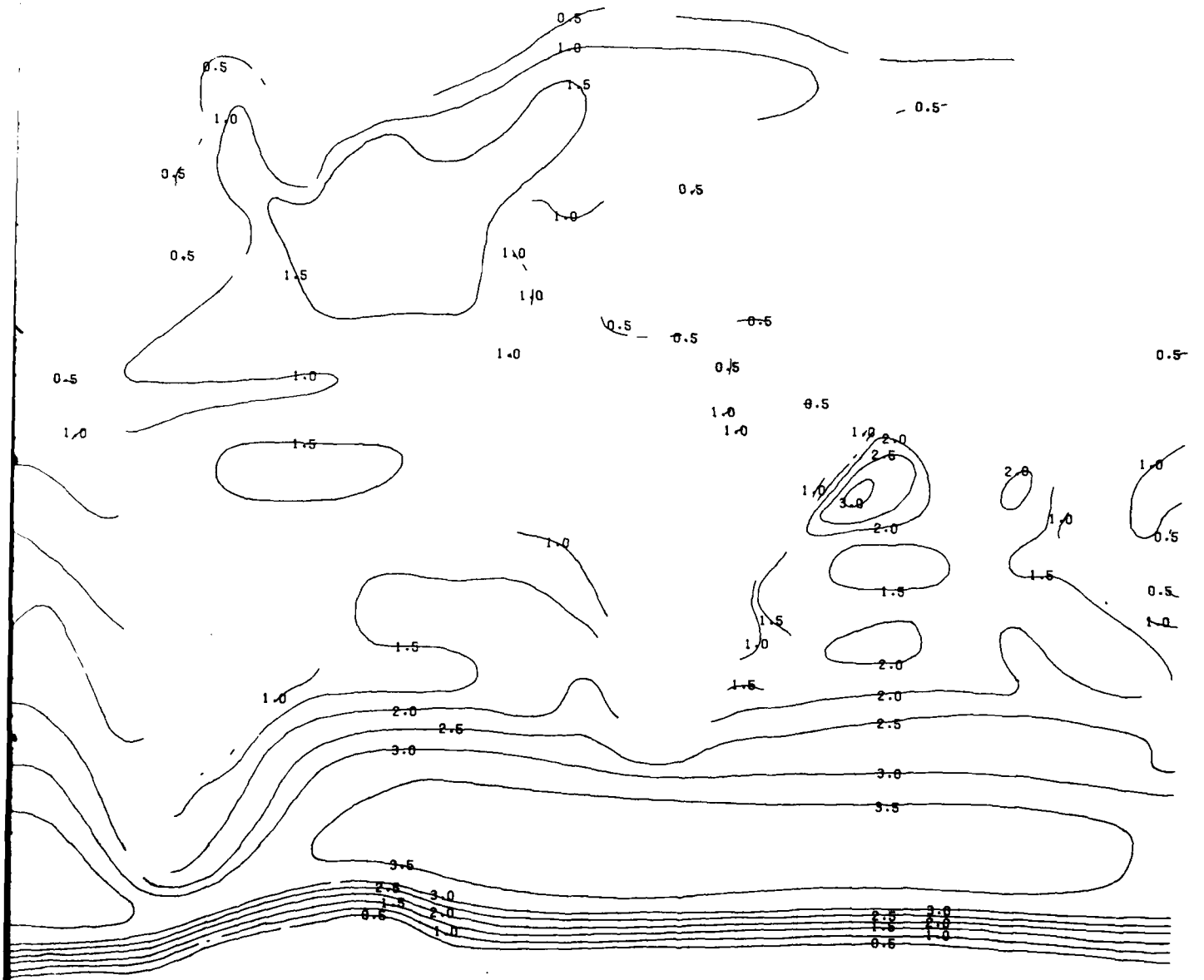
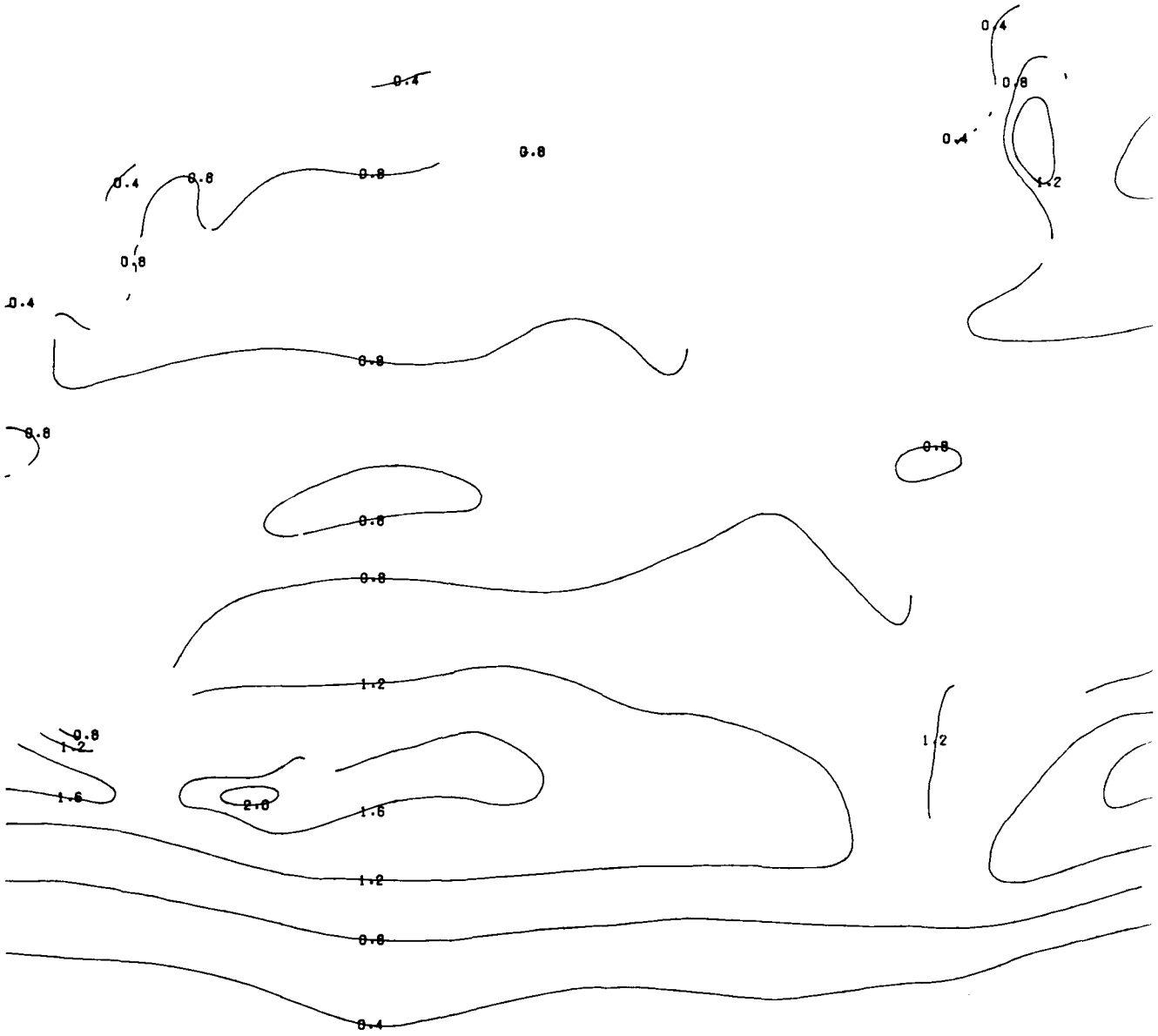


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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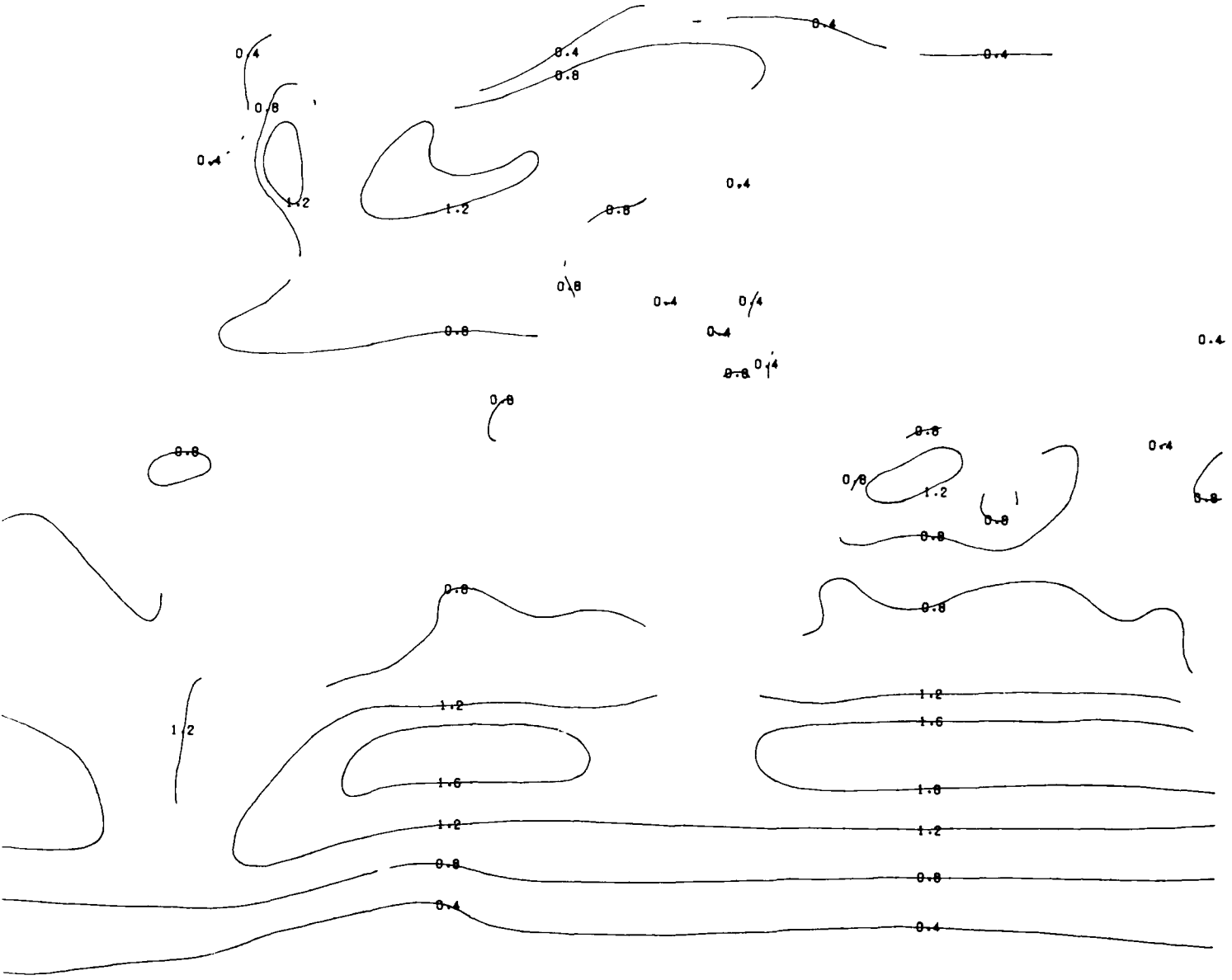

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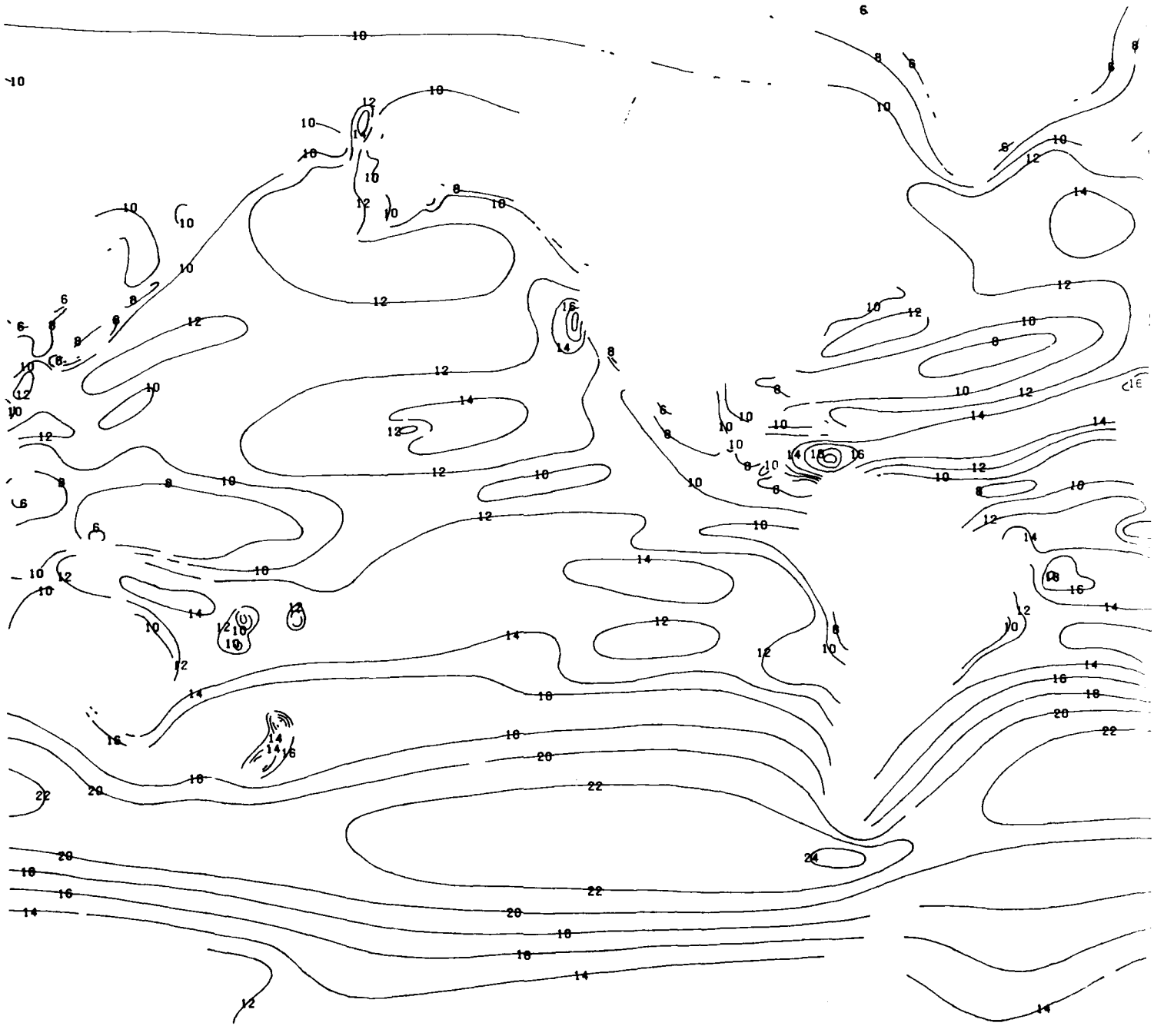
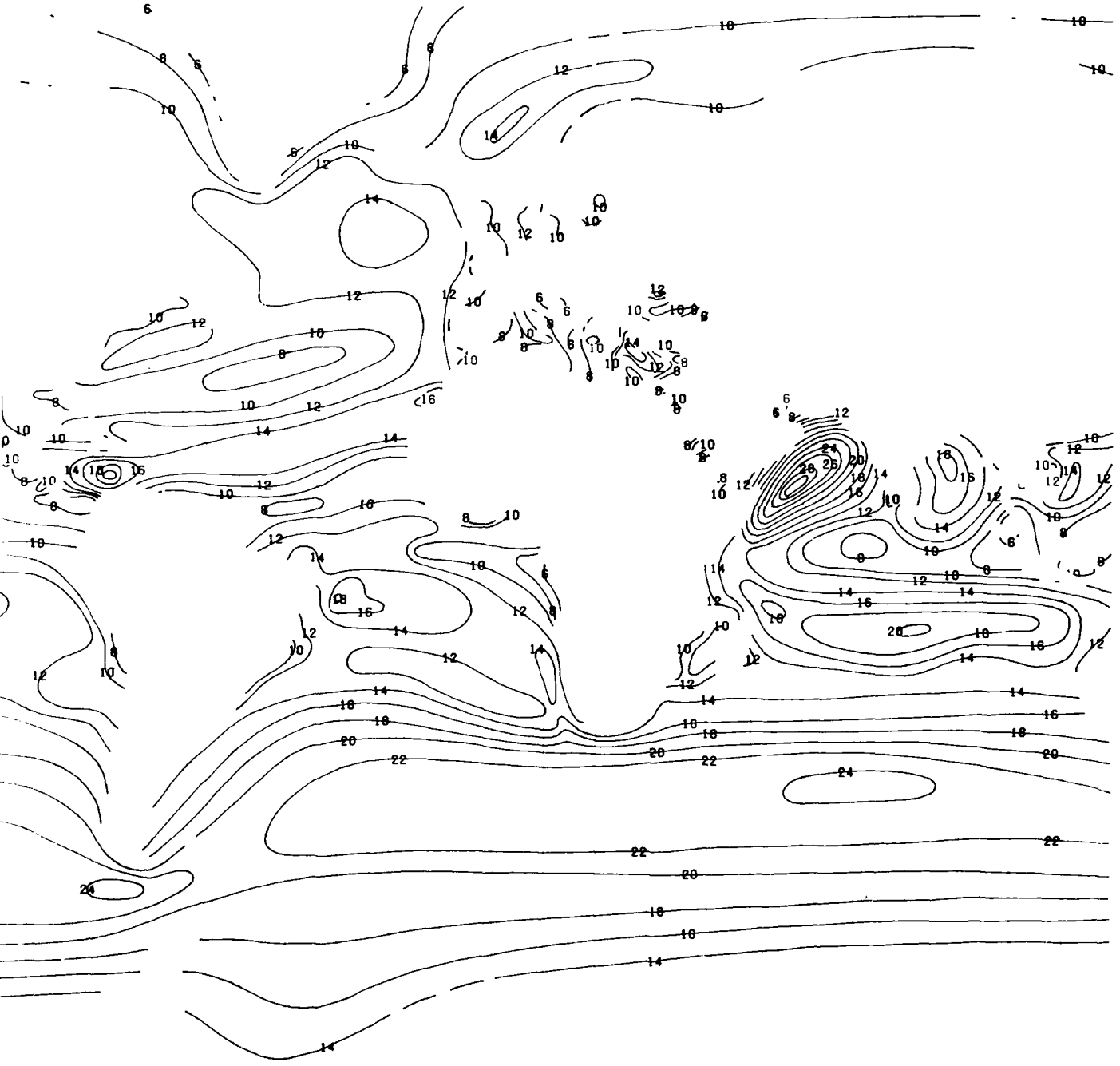
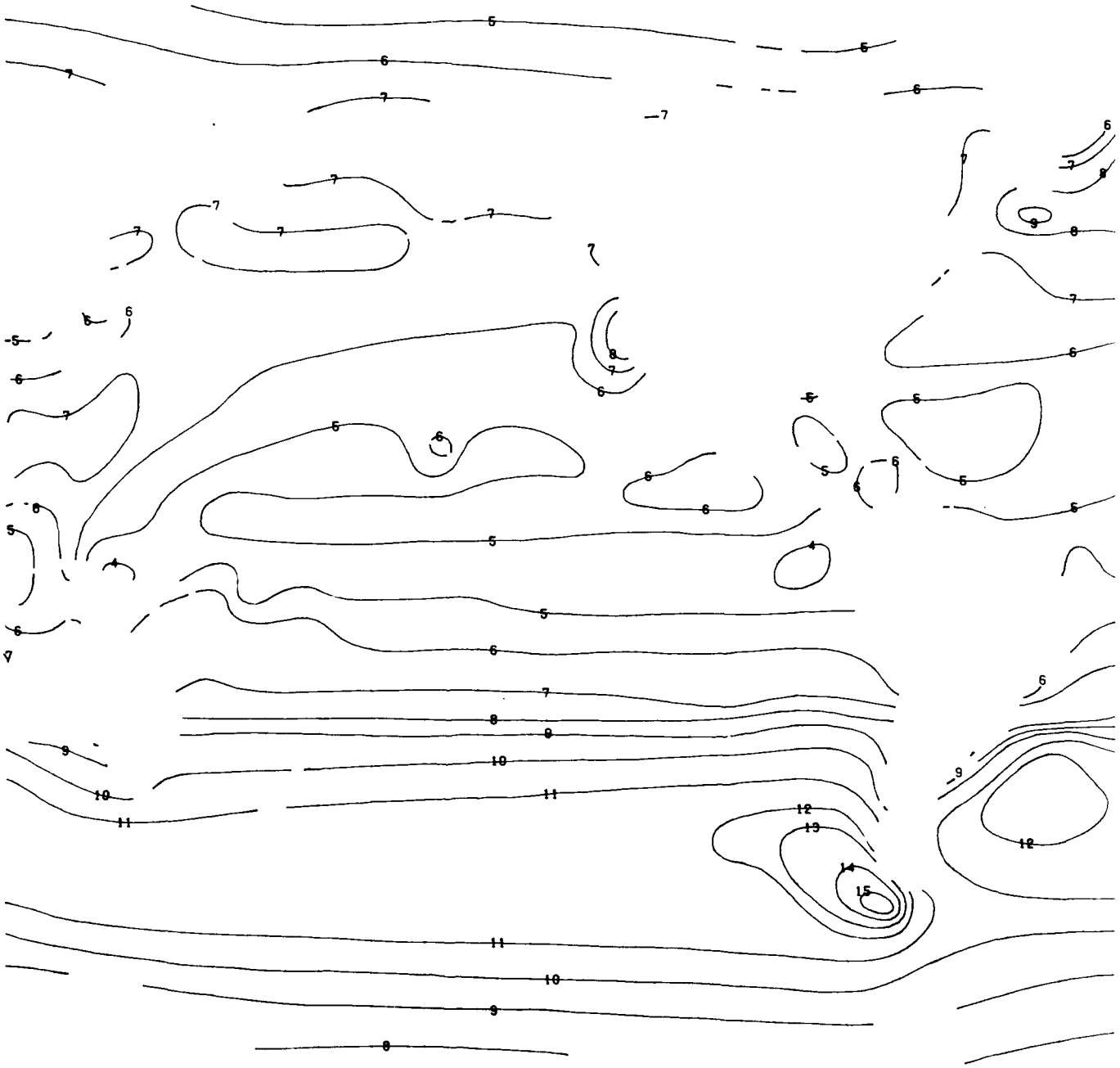


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



EVIATIONS

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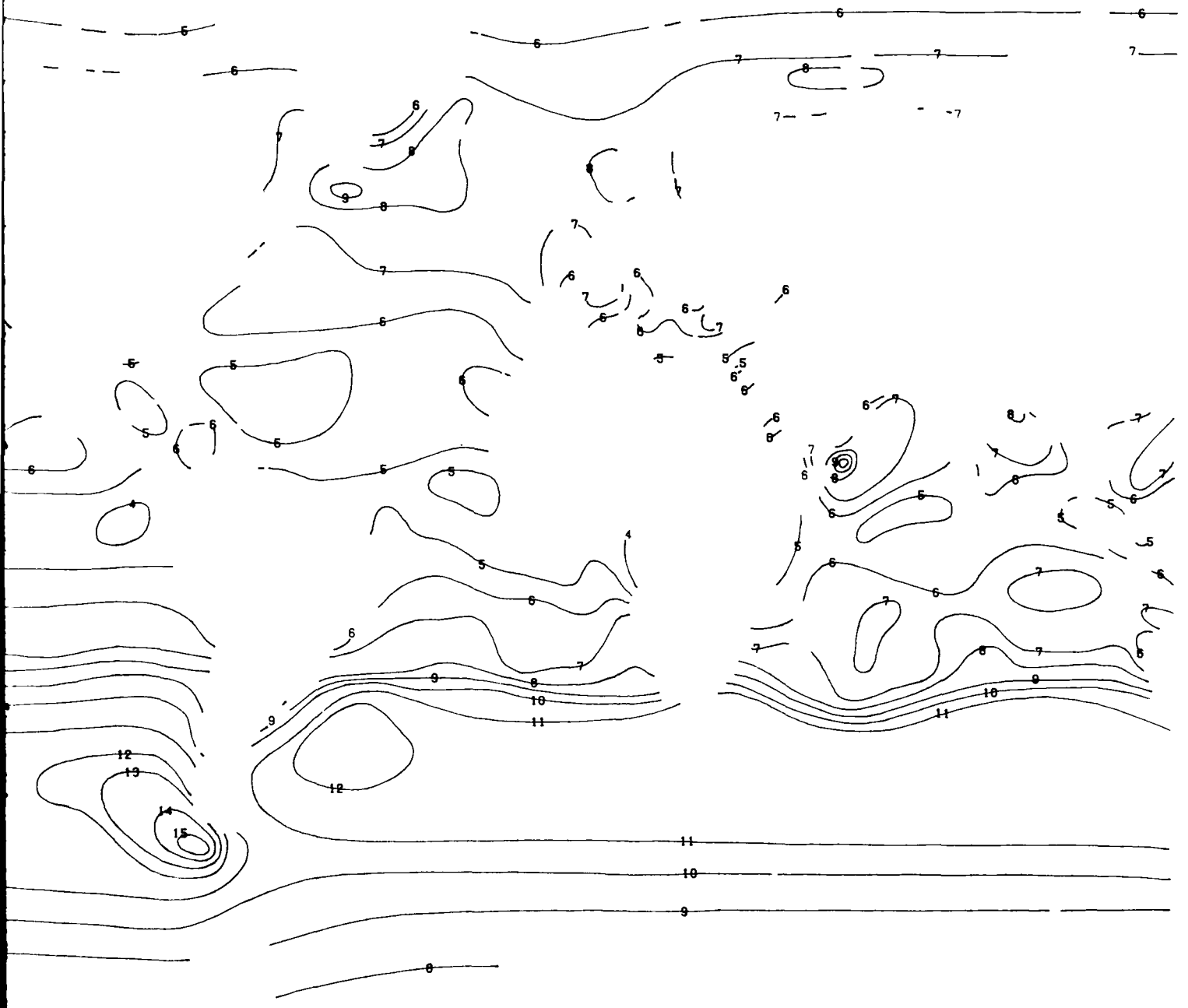

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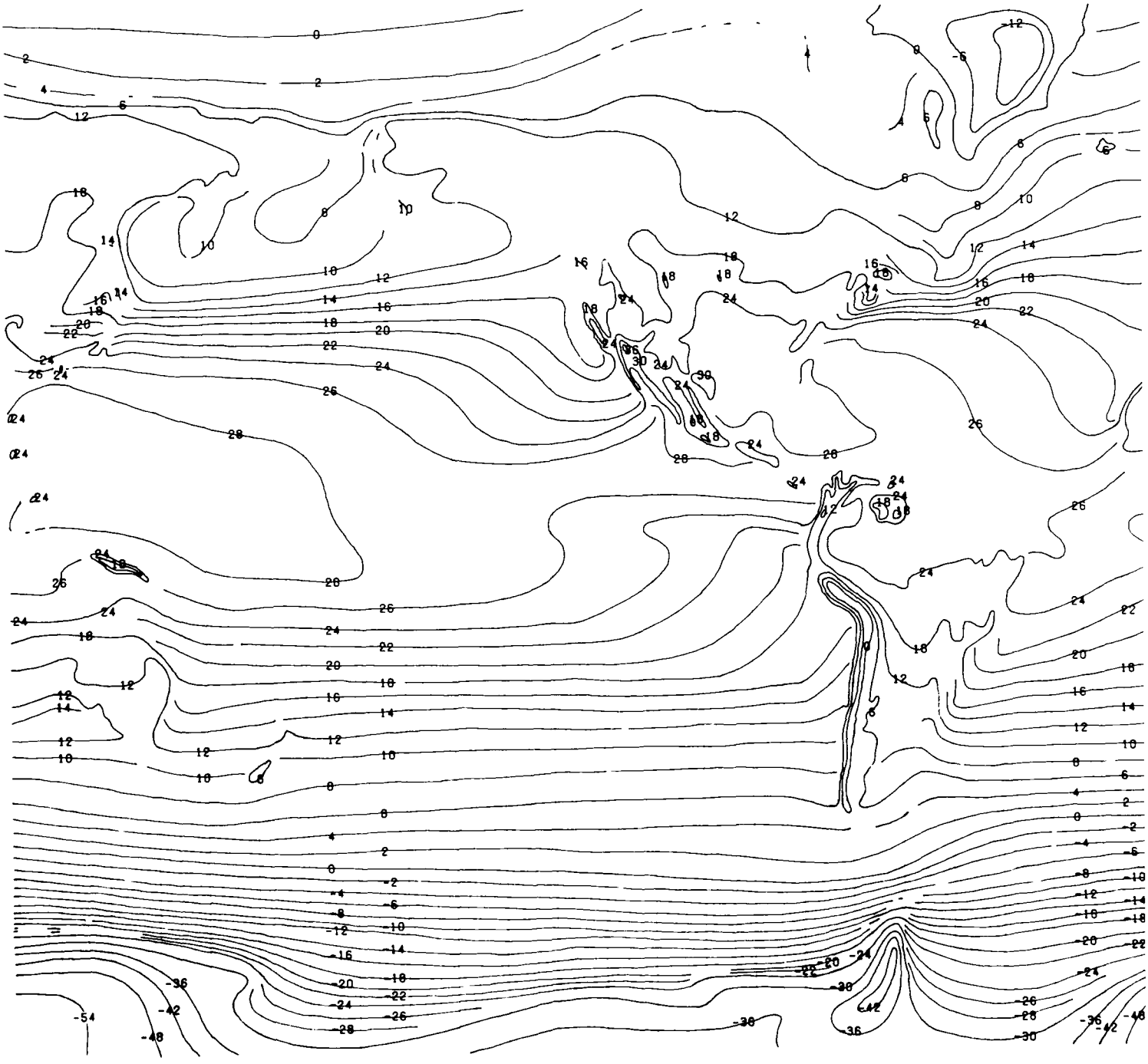
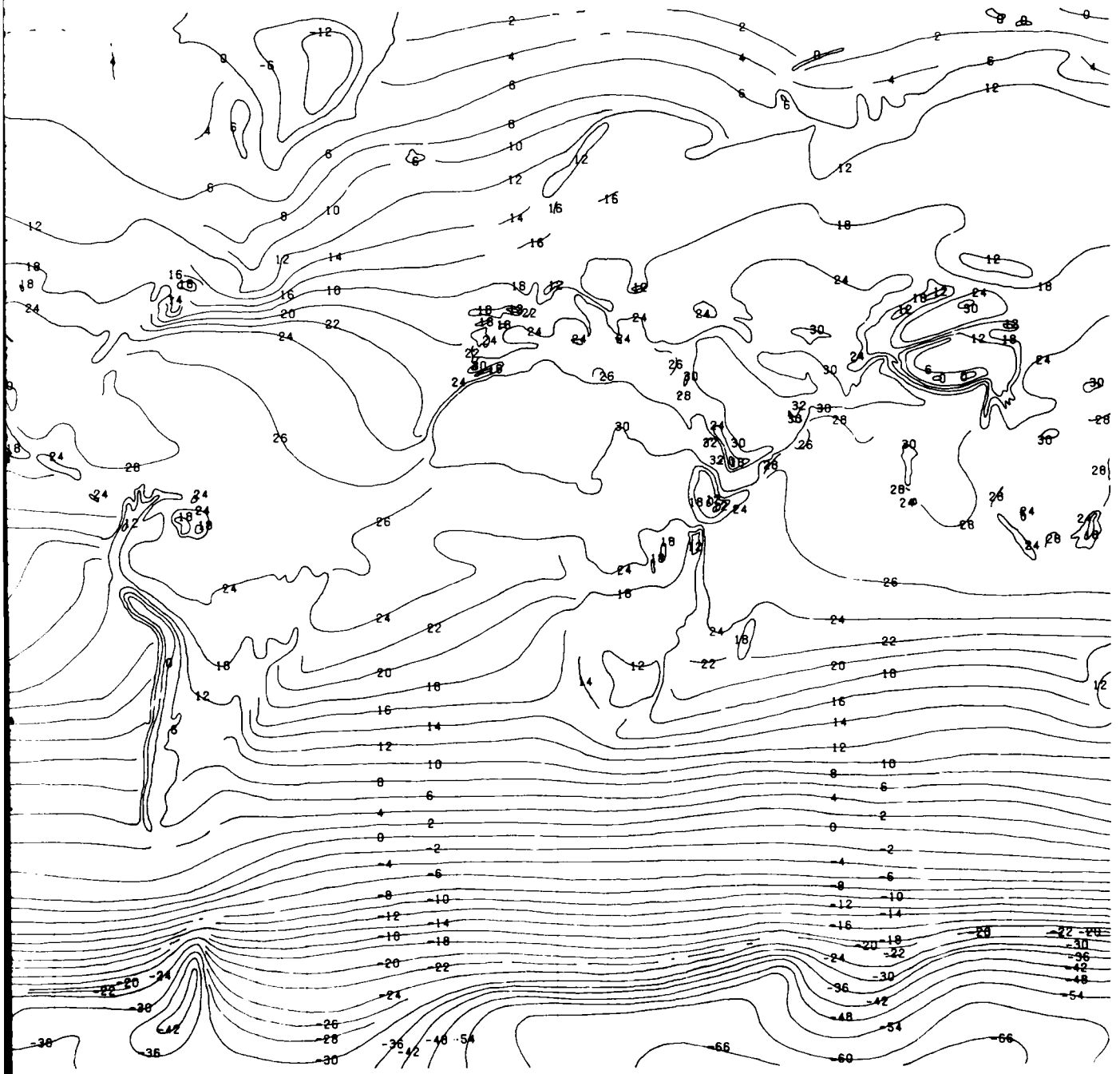
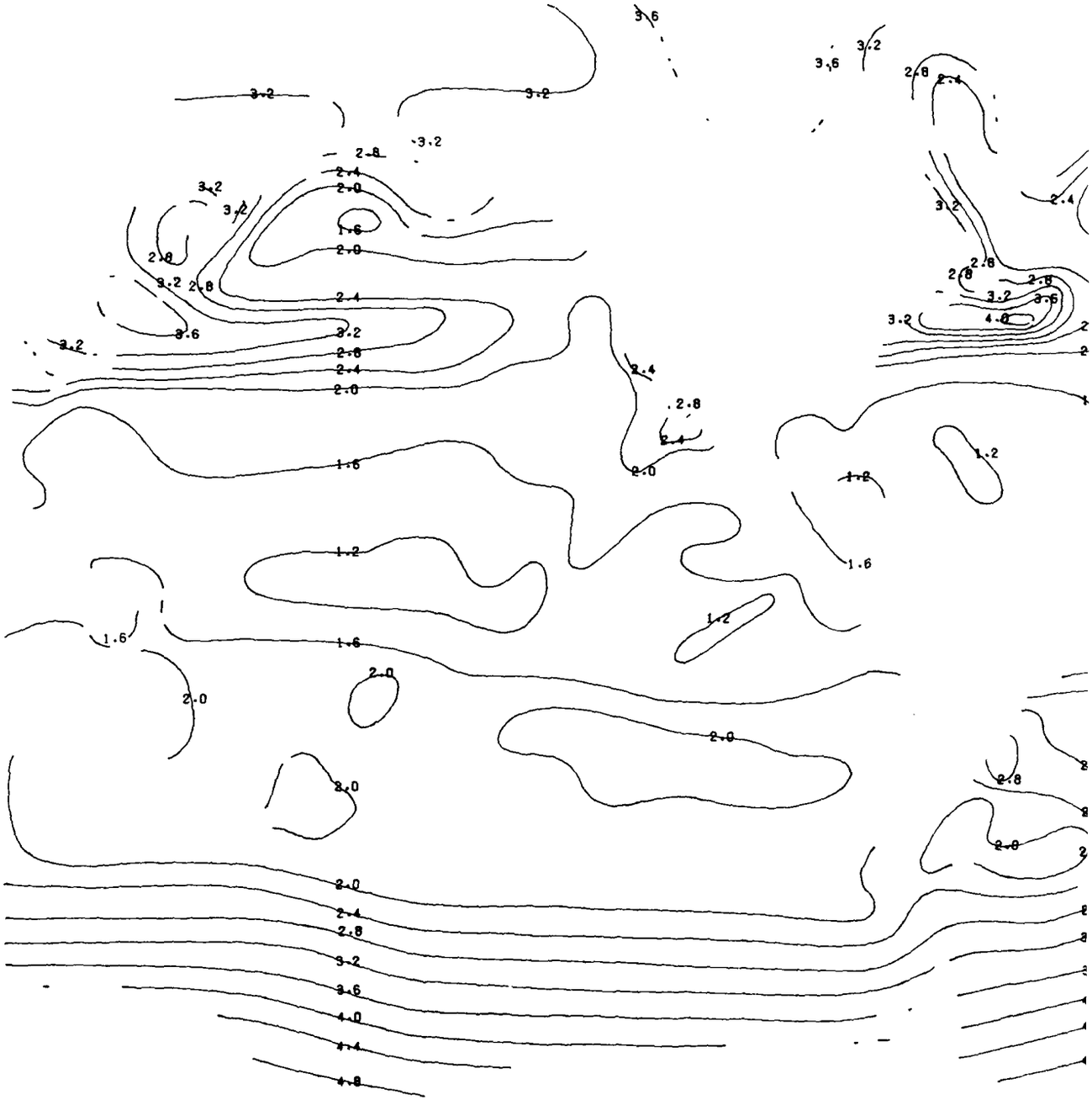


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



NDARD DEVIATIONS

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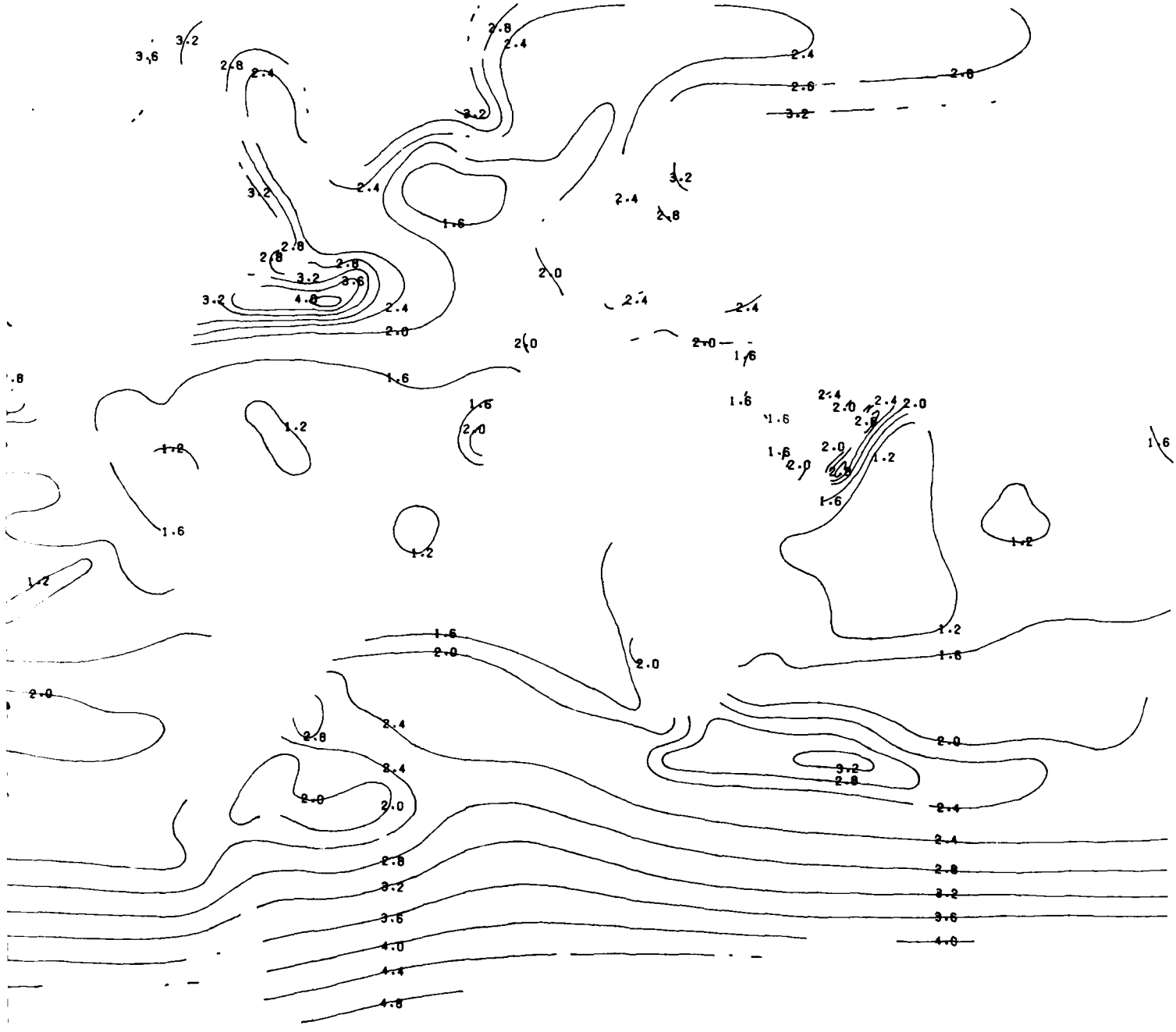

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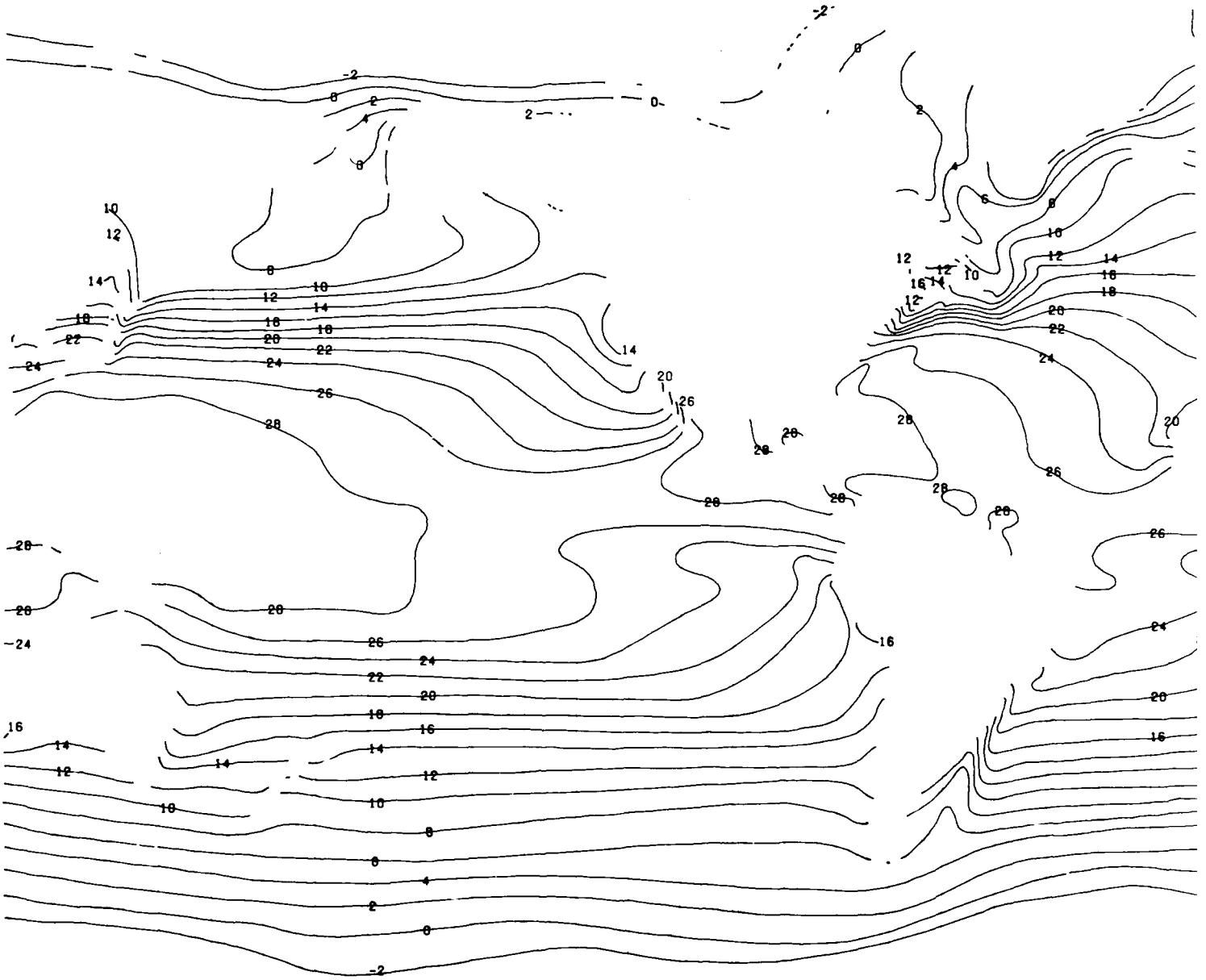
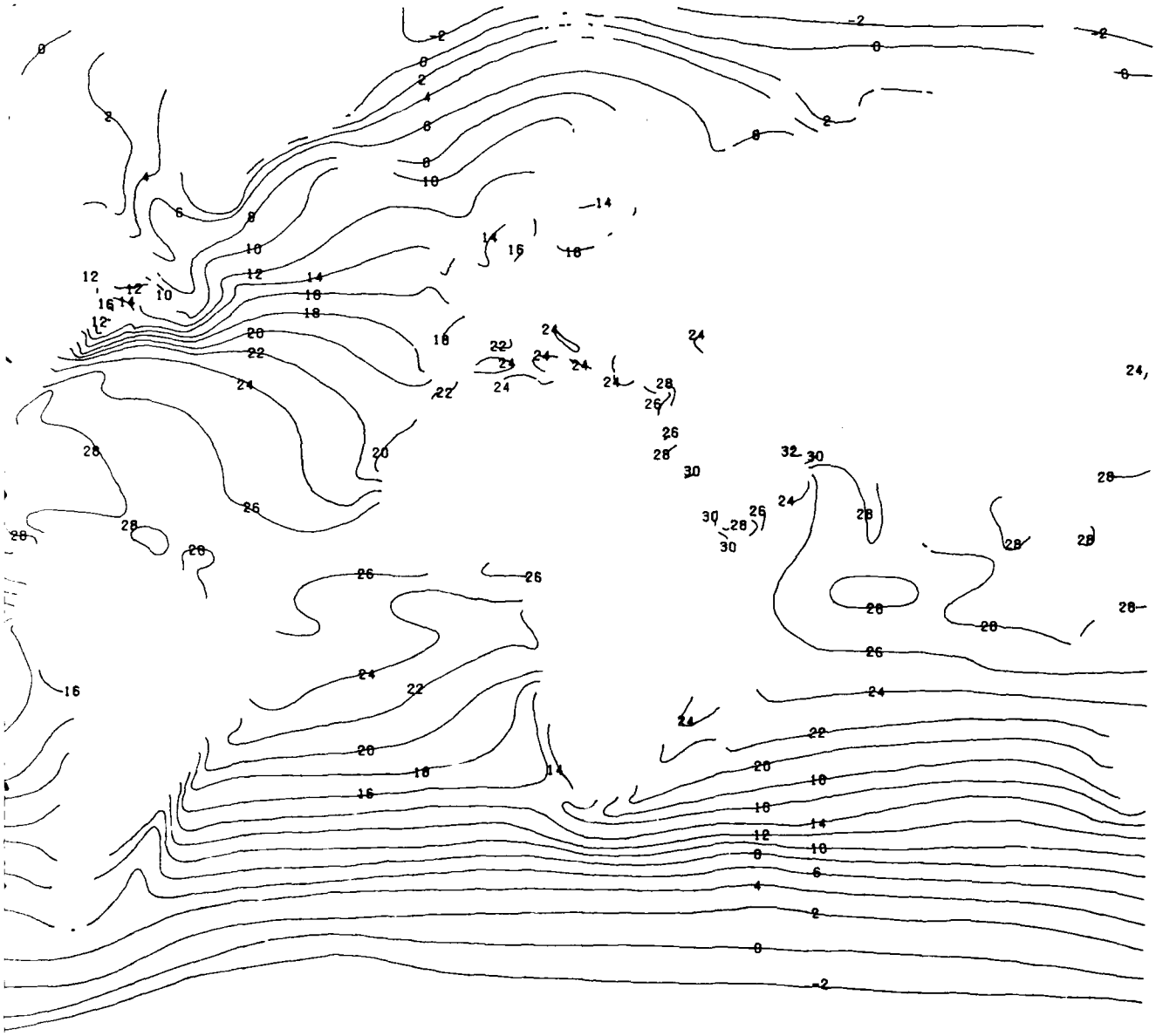
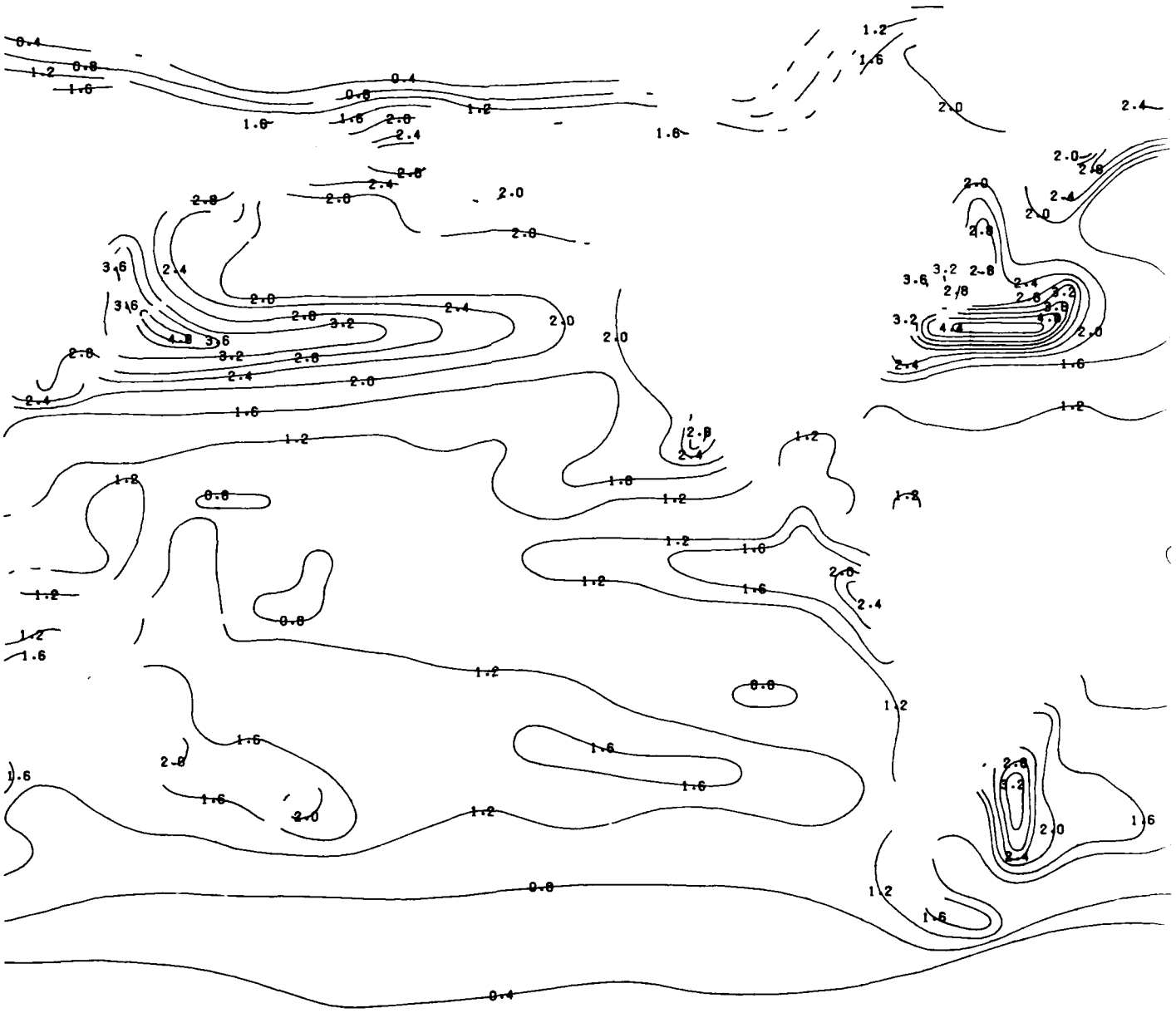


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



ARD DEVIATIONS

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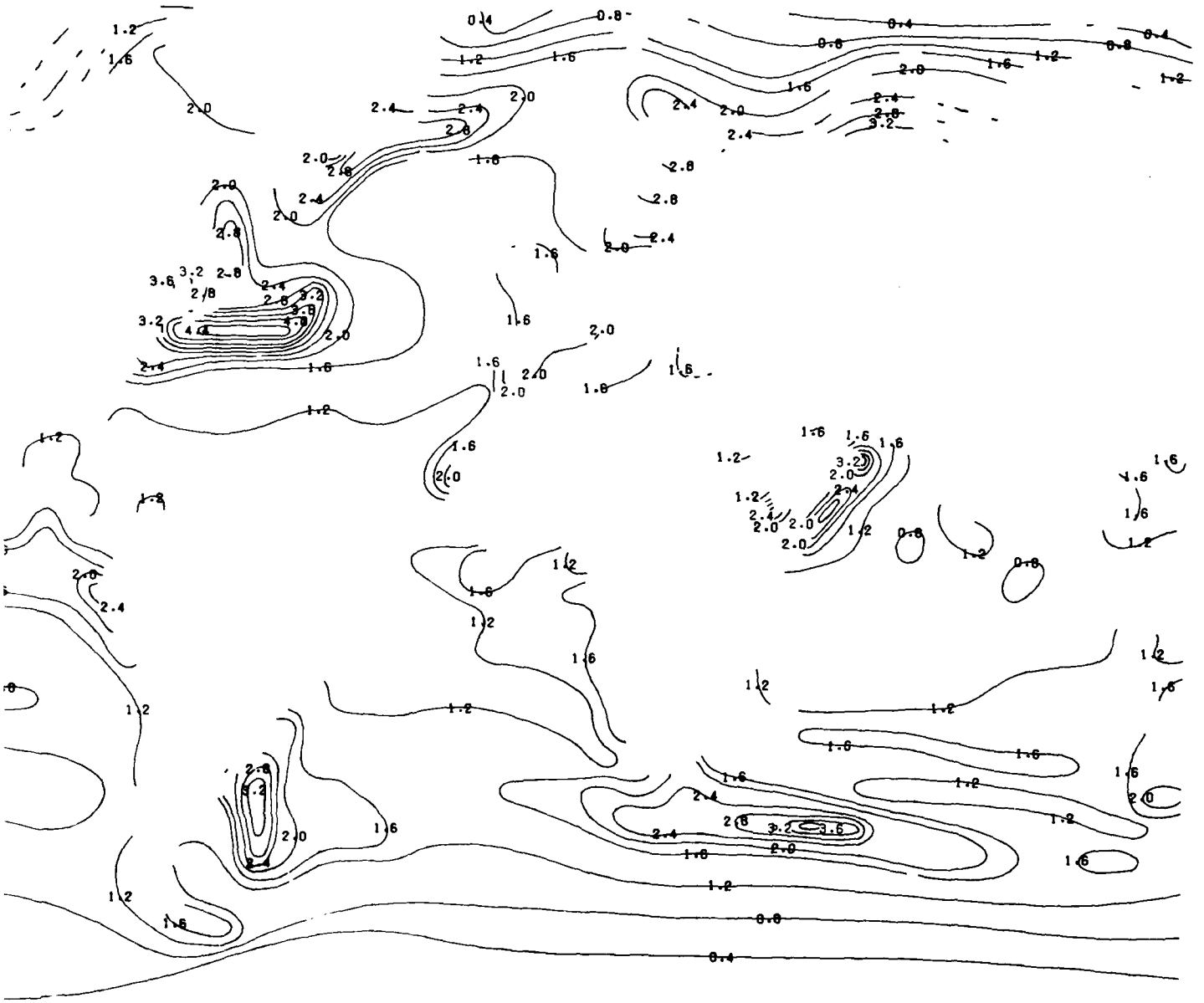

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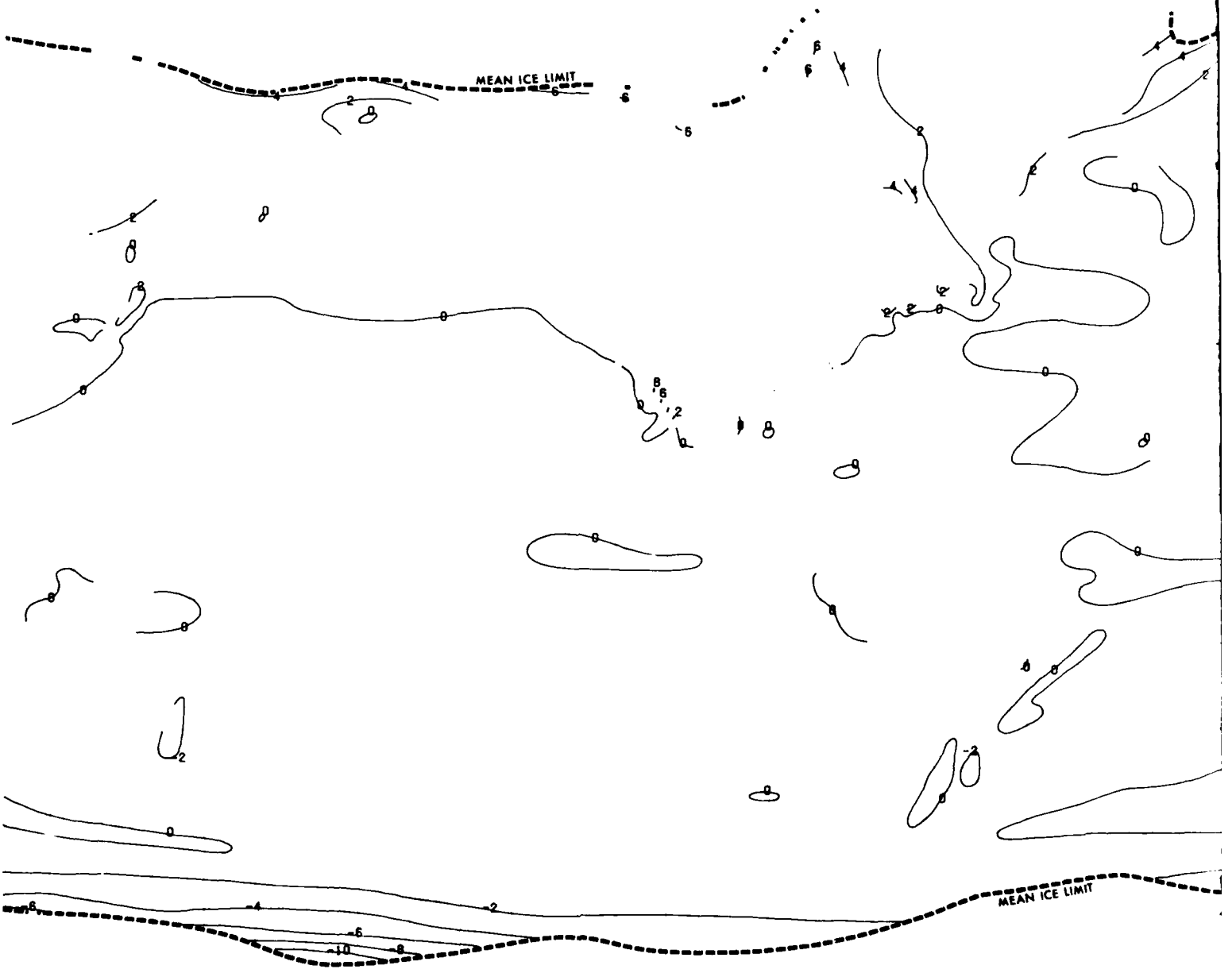
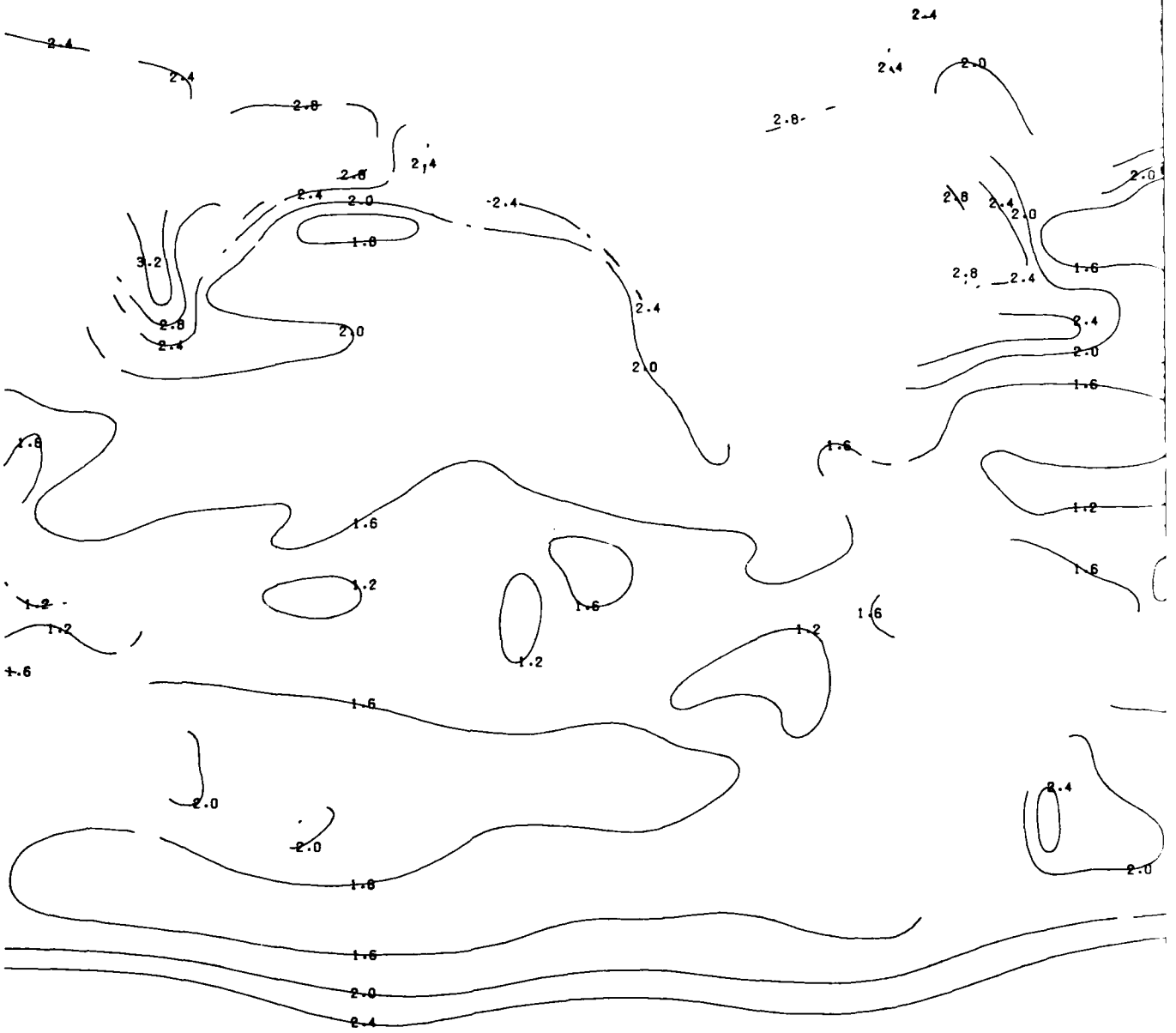


AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATION



STANDARD DEVIATIONS

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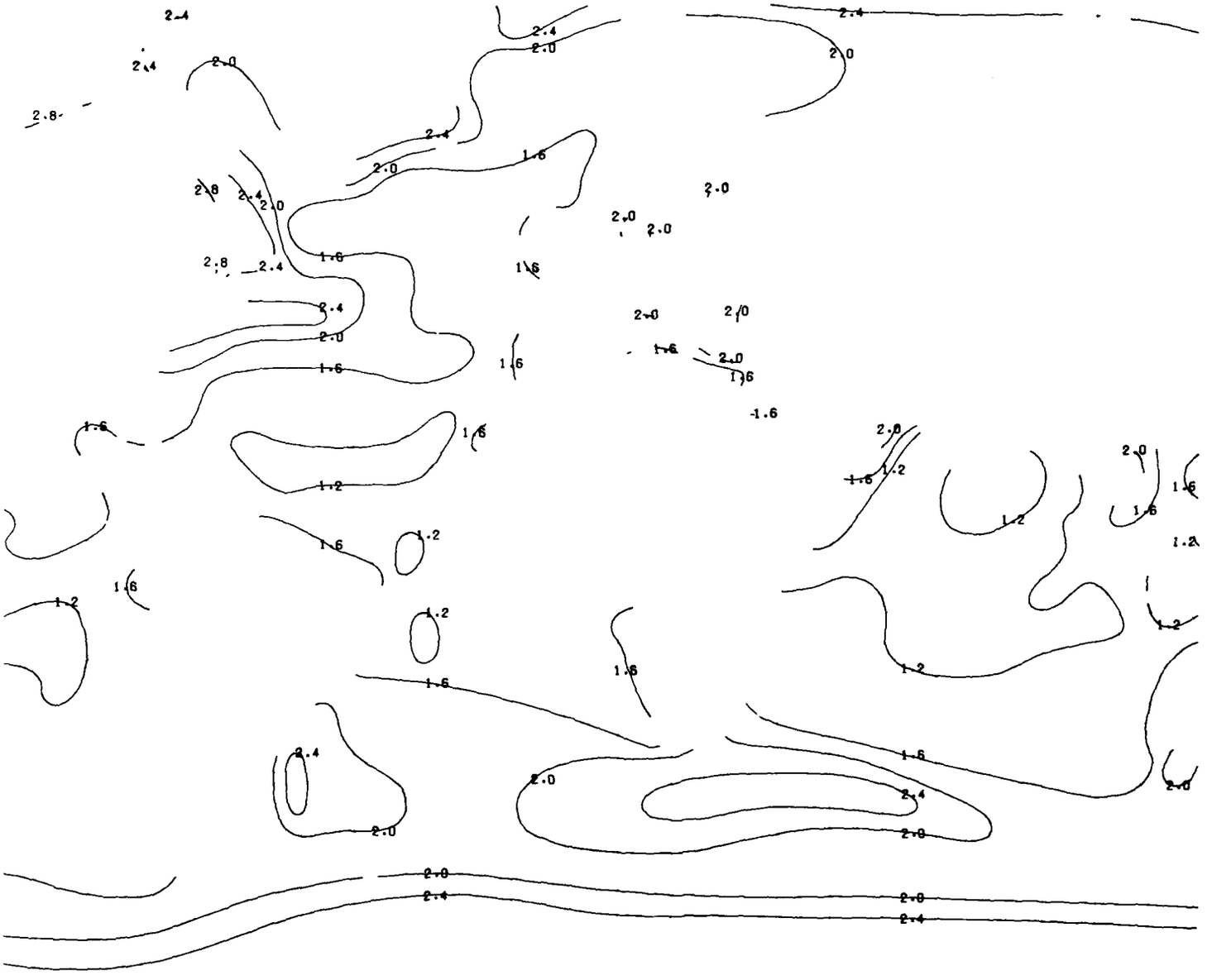

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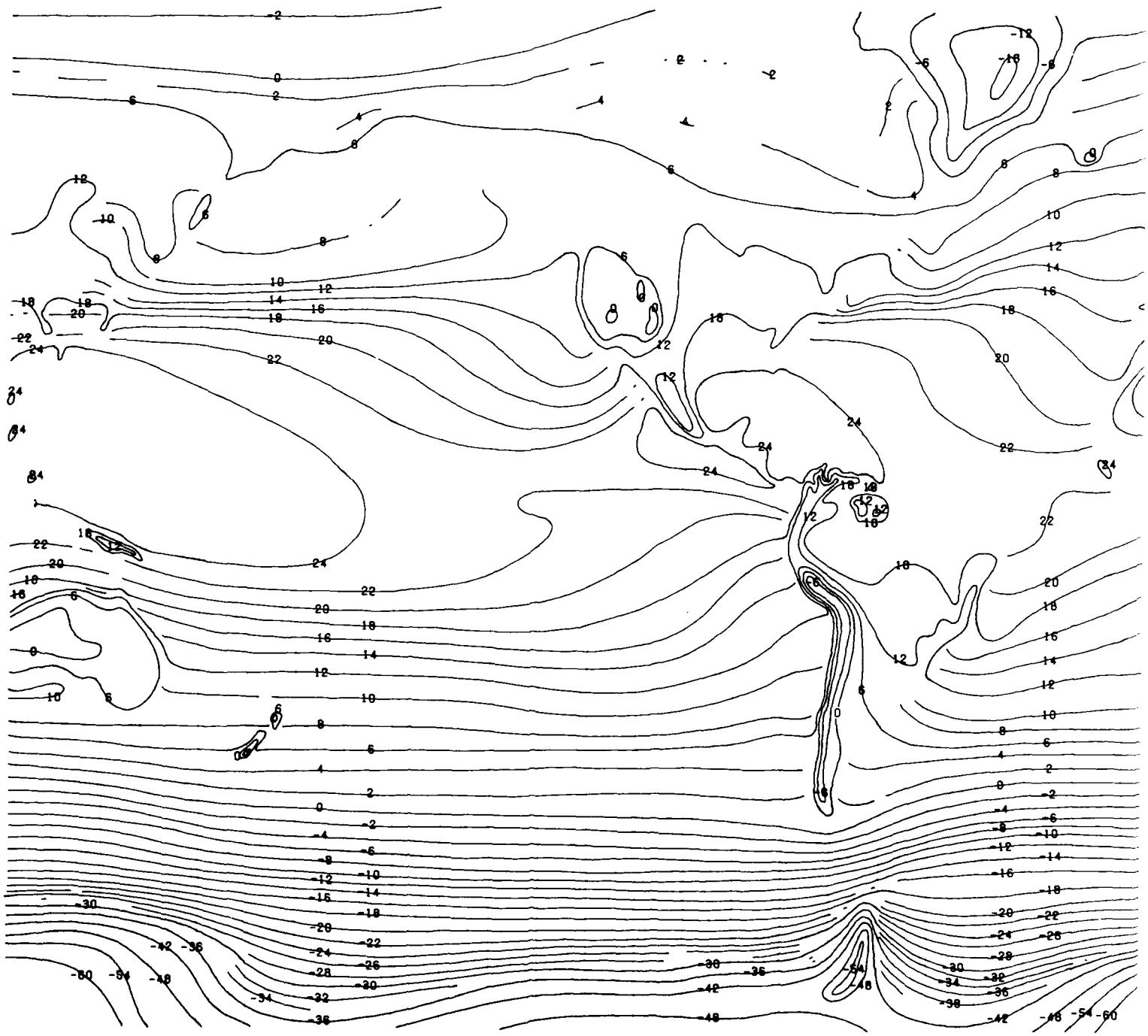
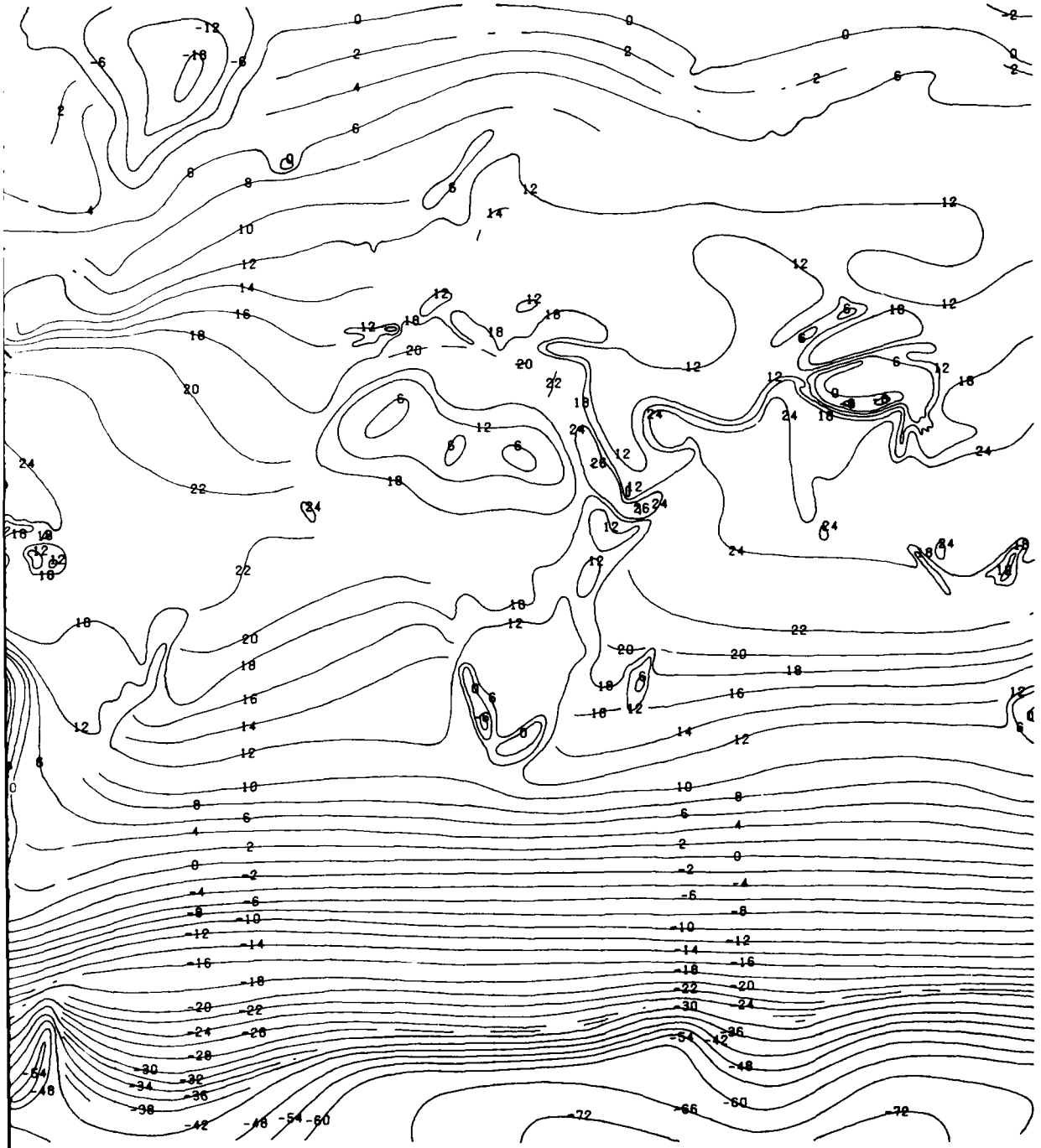
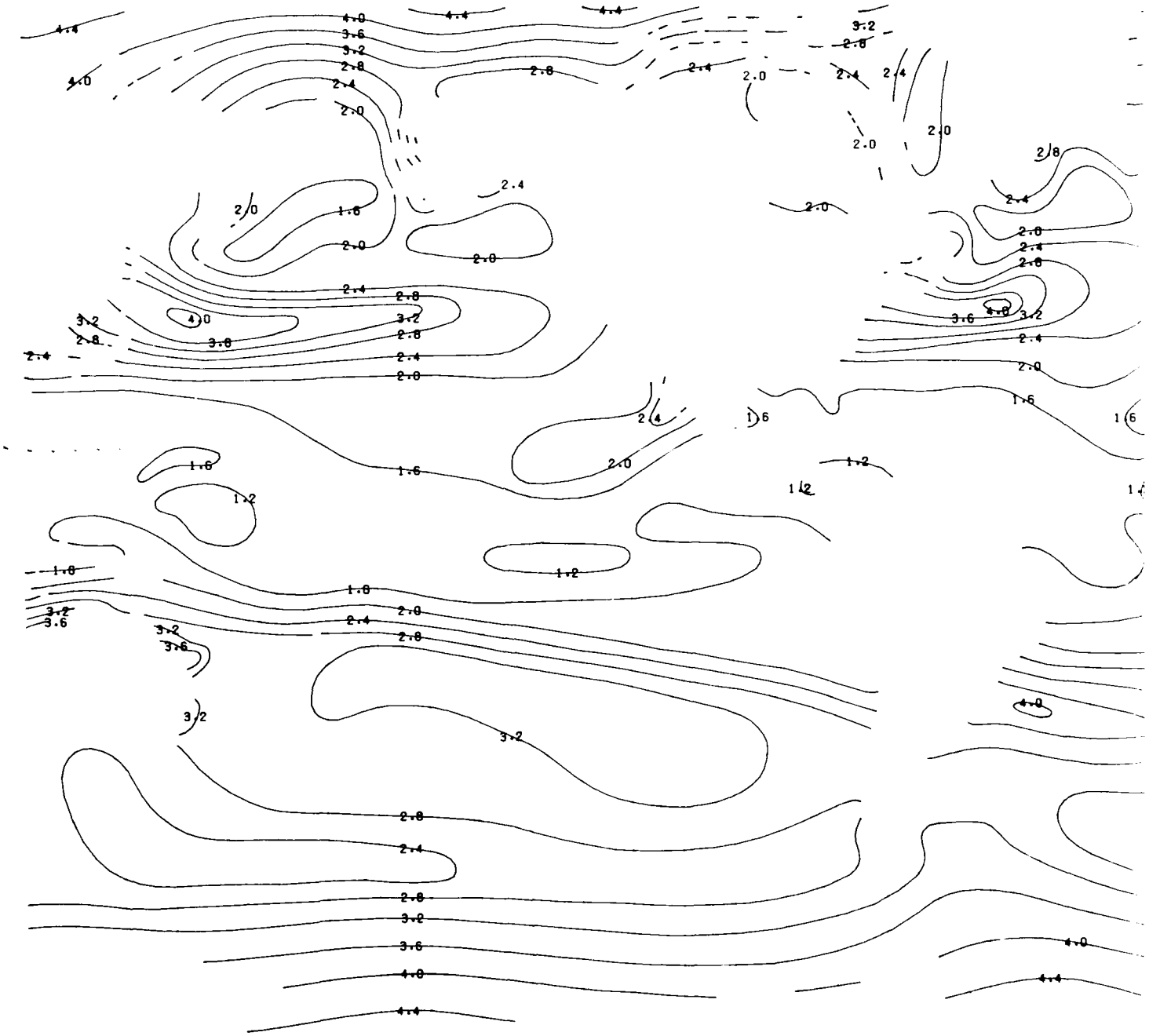


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



IDARD DEVIATIONS

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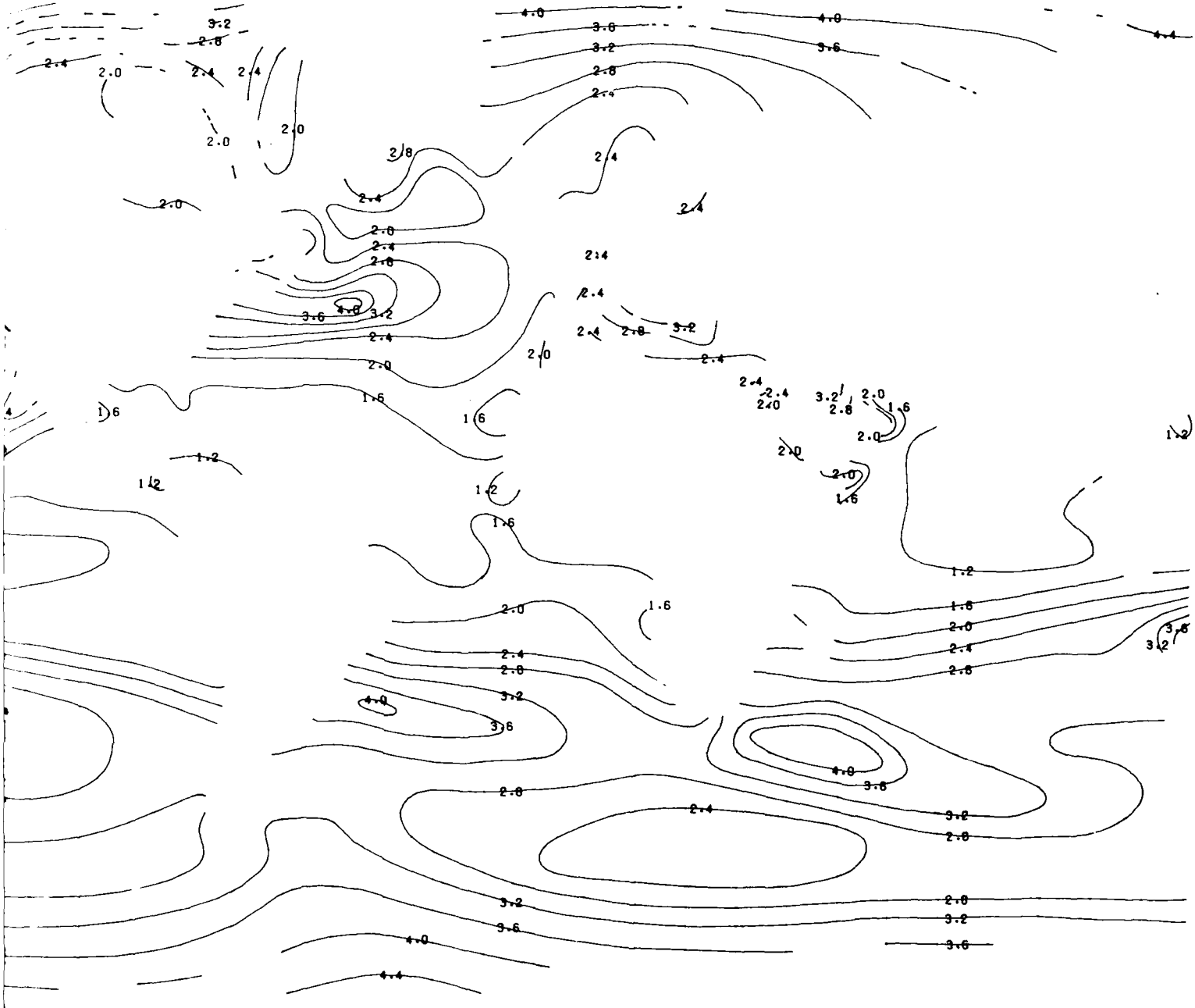

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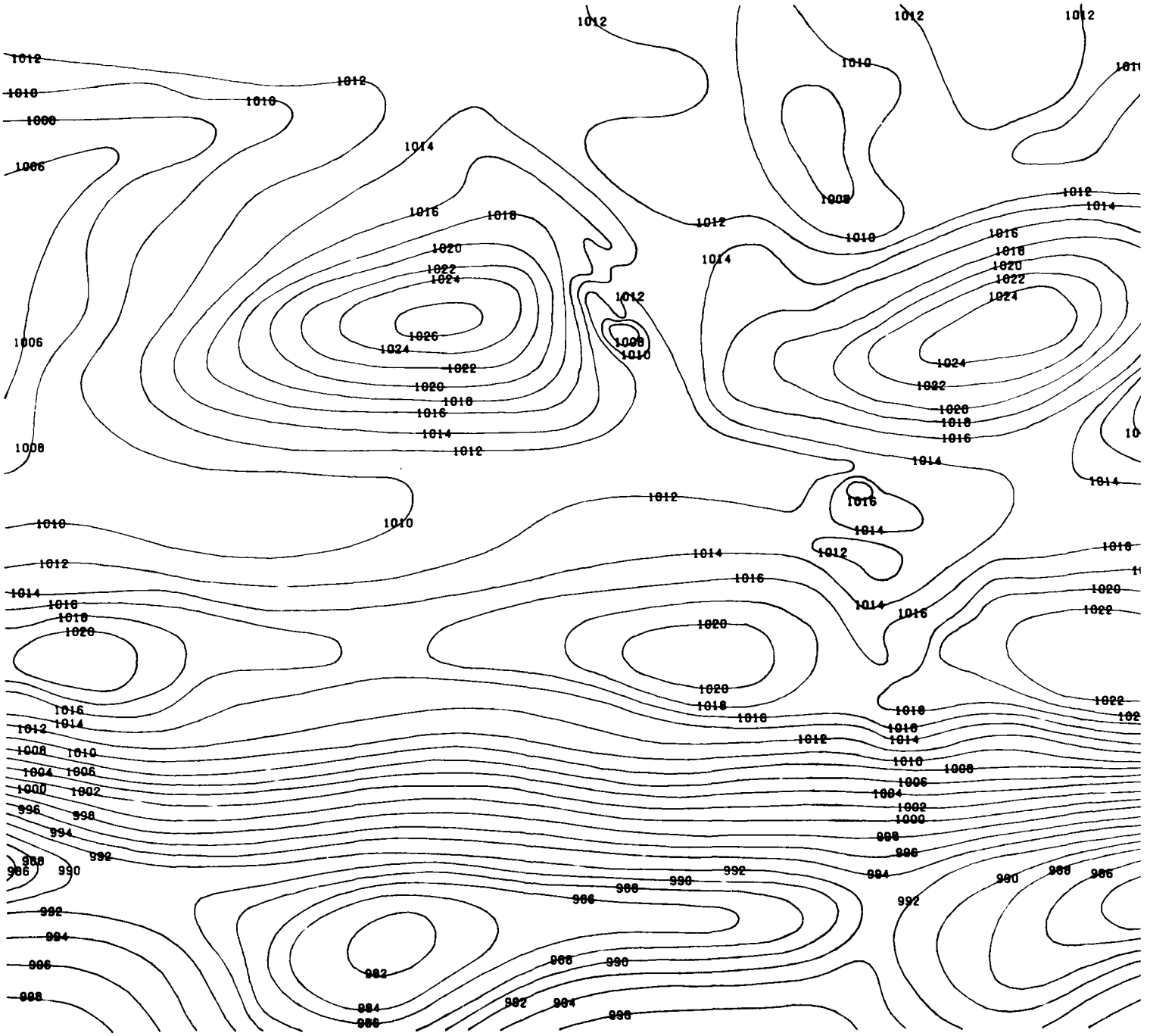
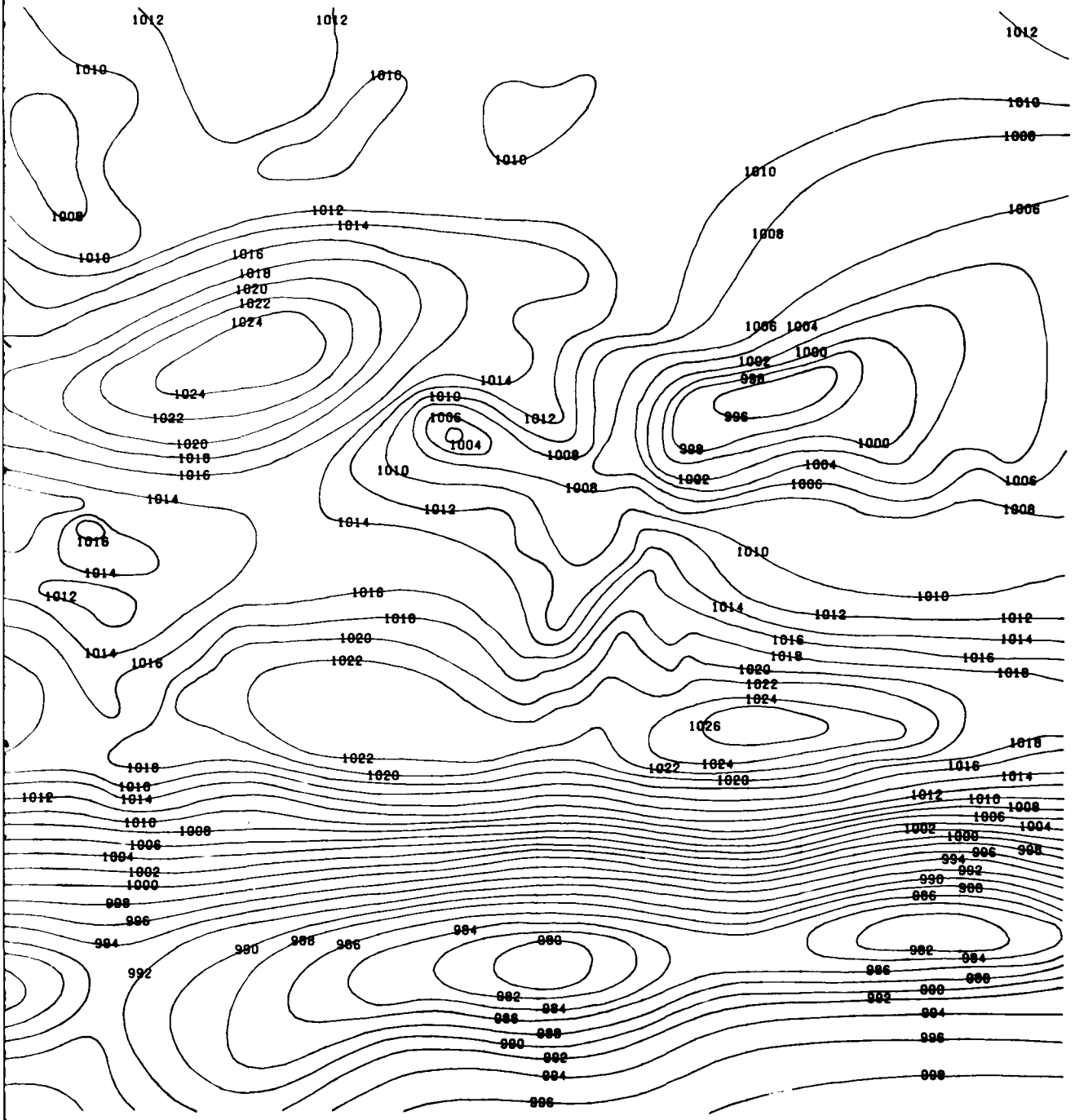
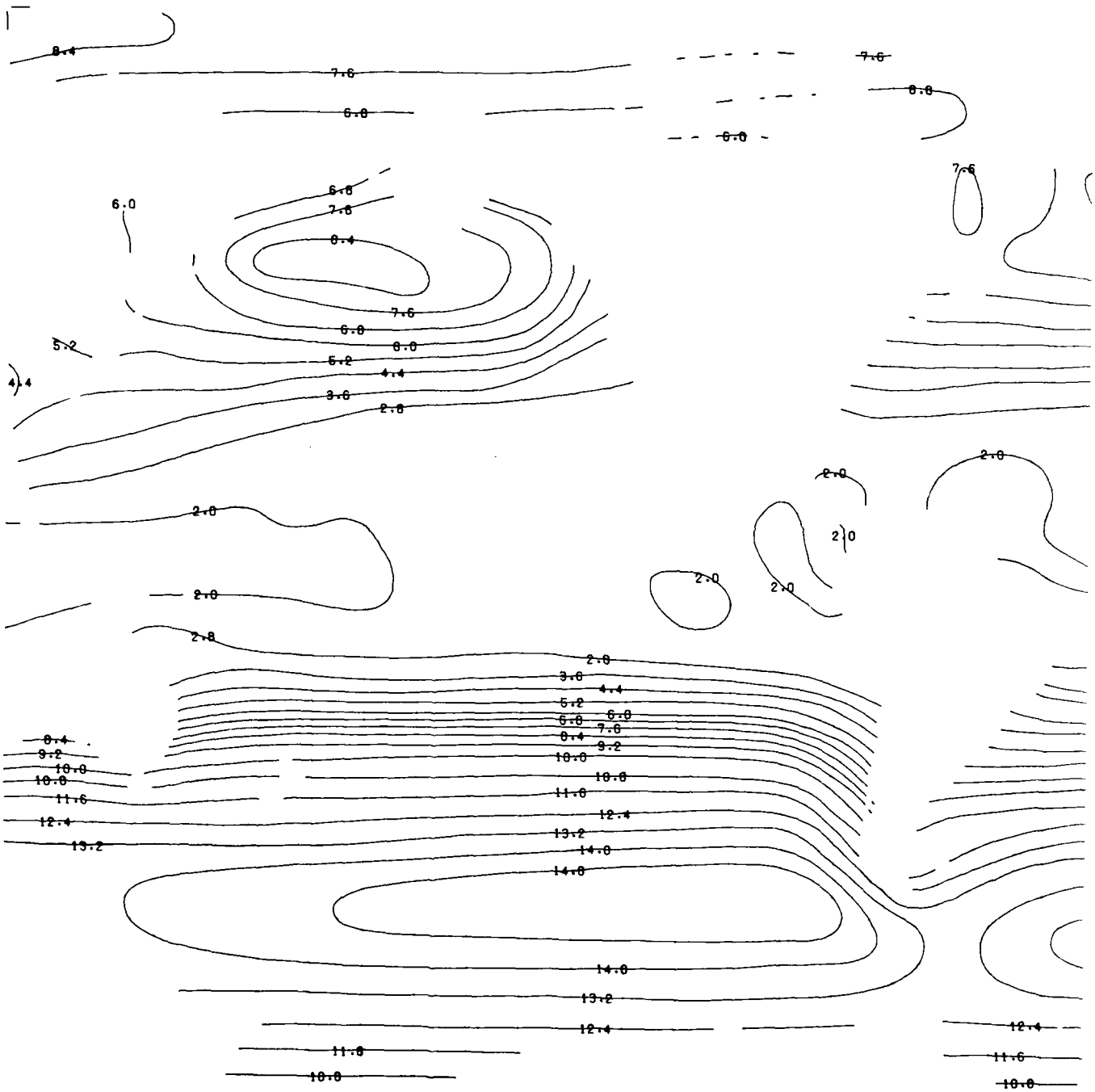


SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



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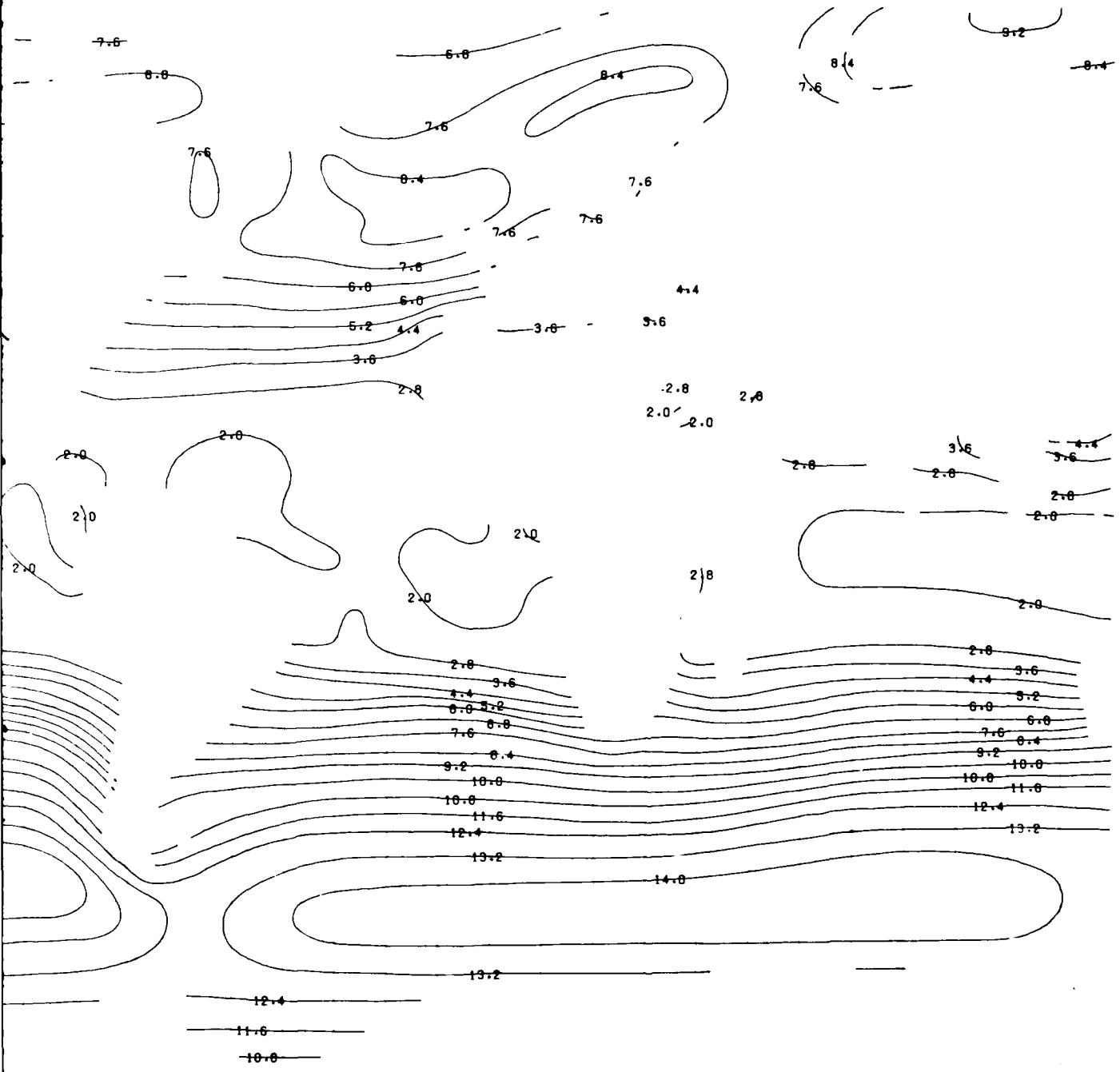

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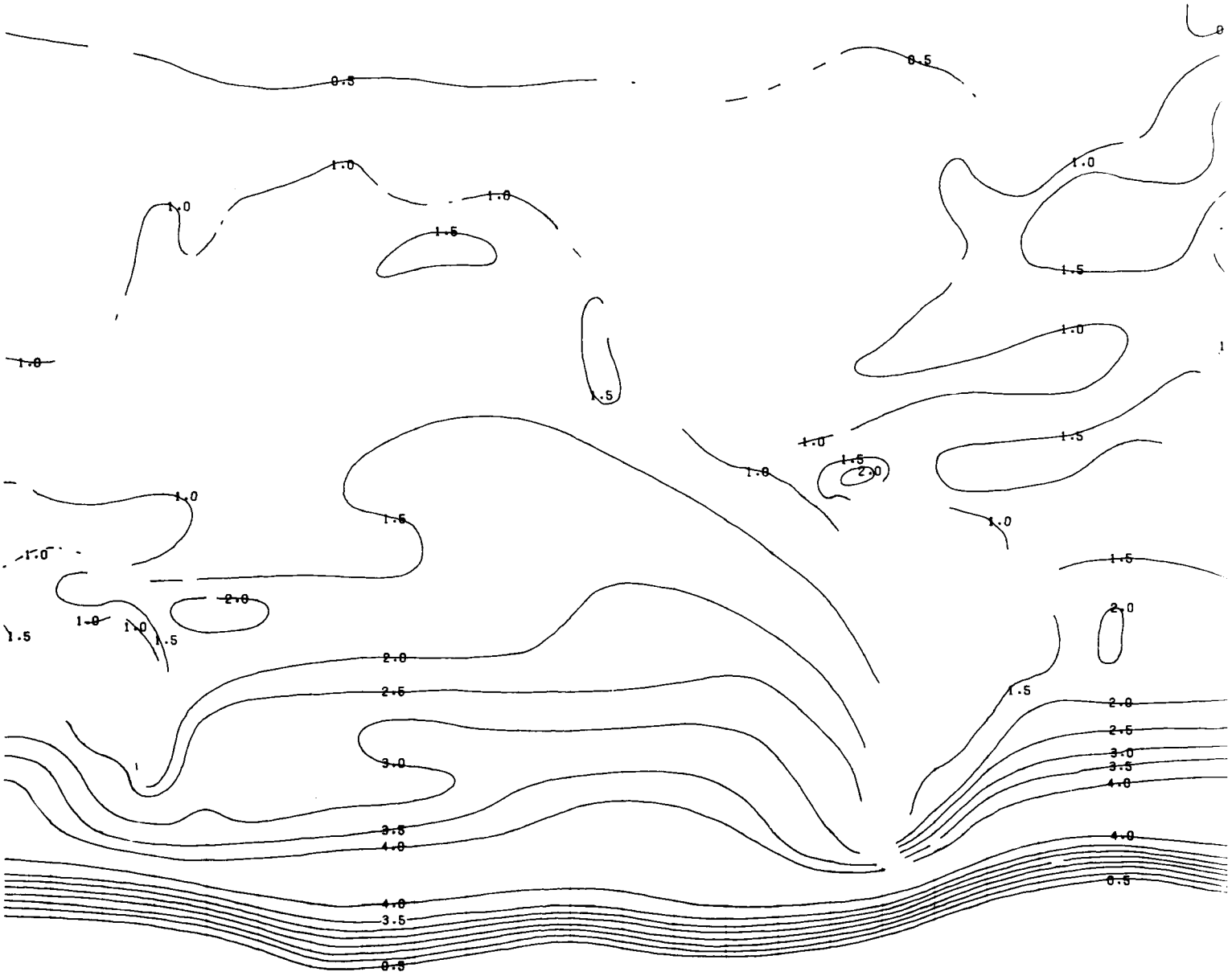
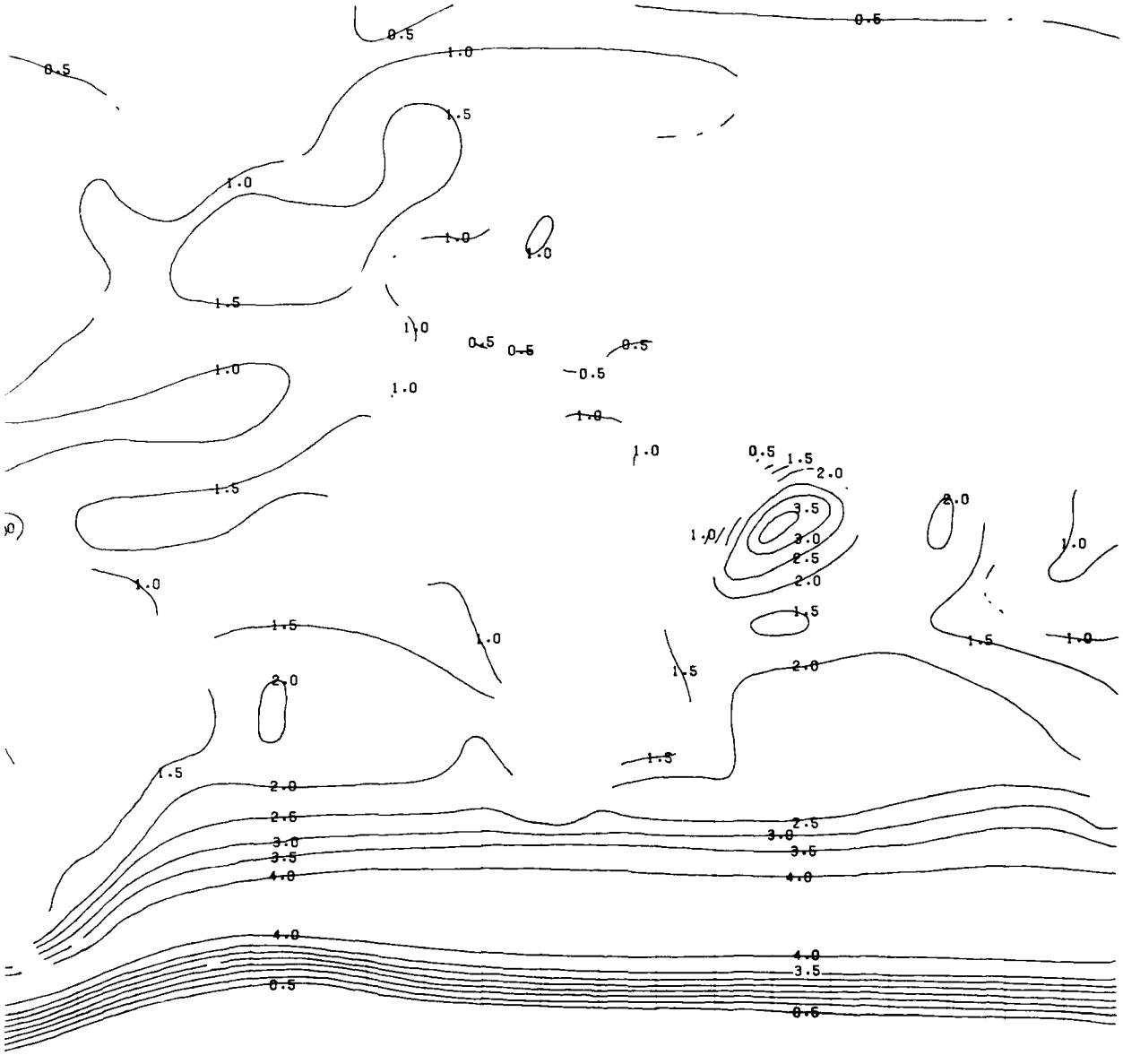


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS

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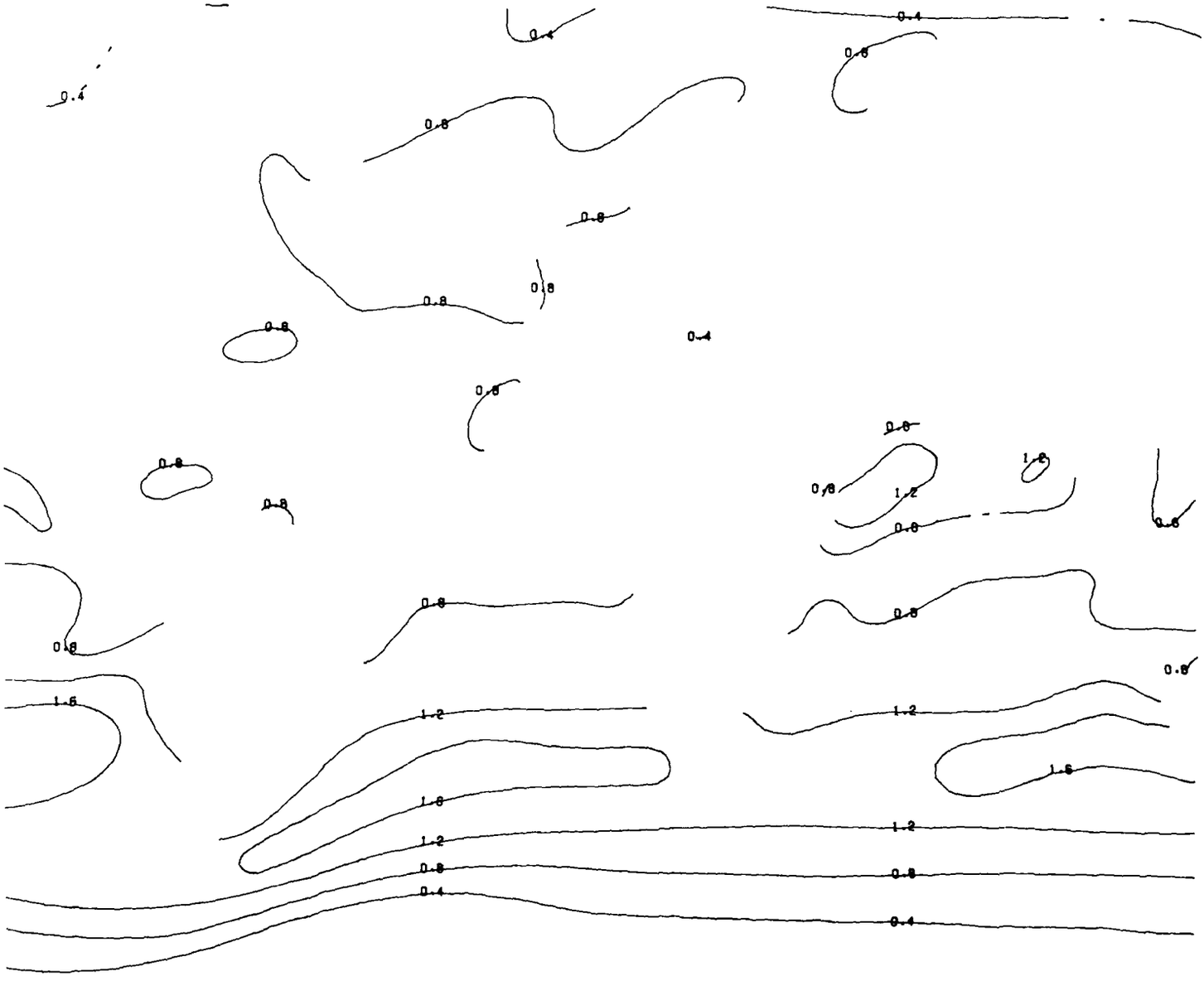
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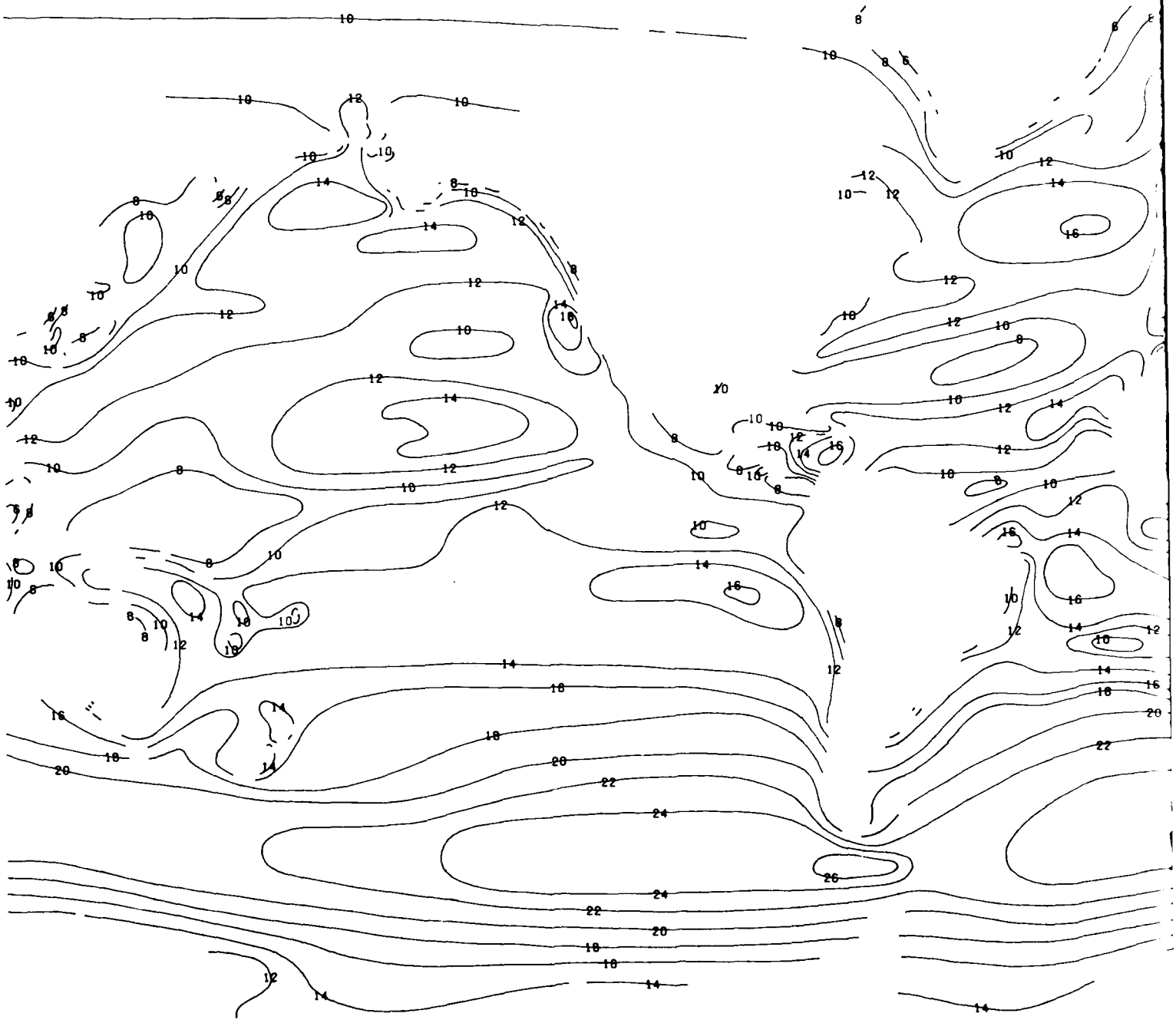
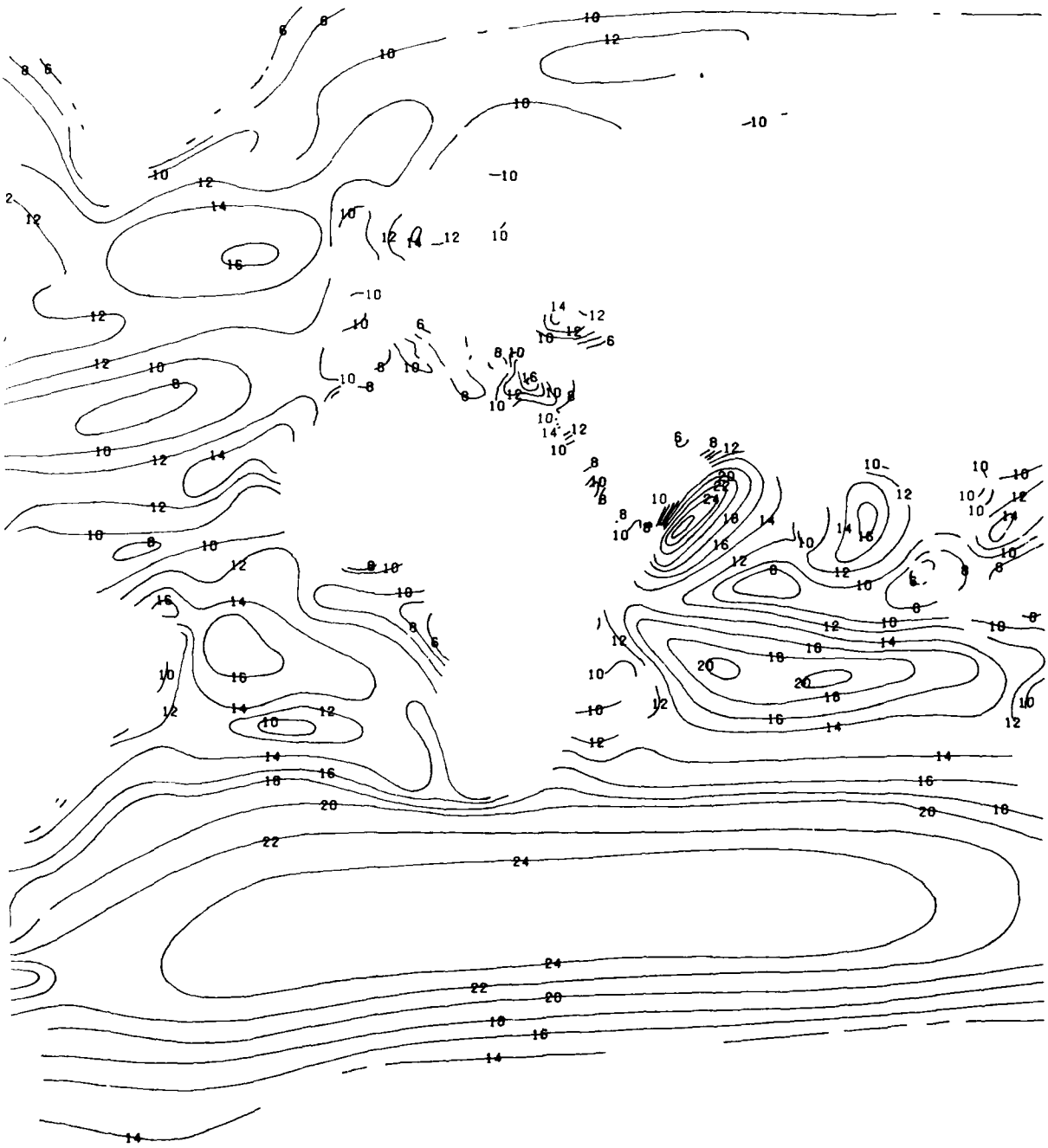
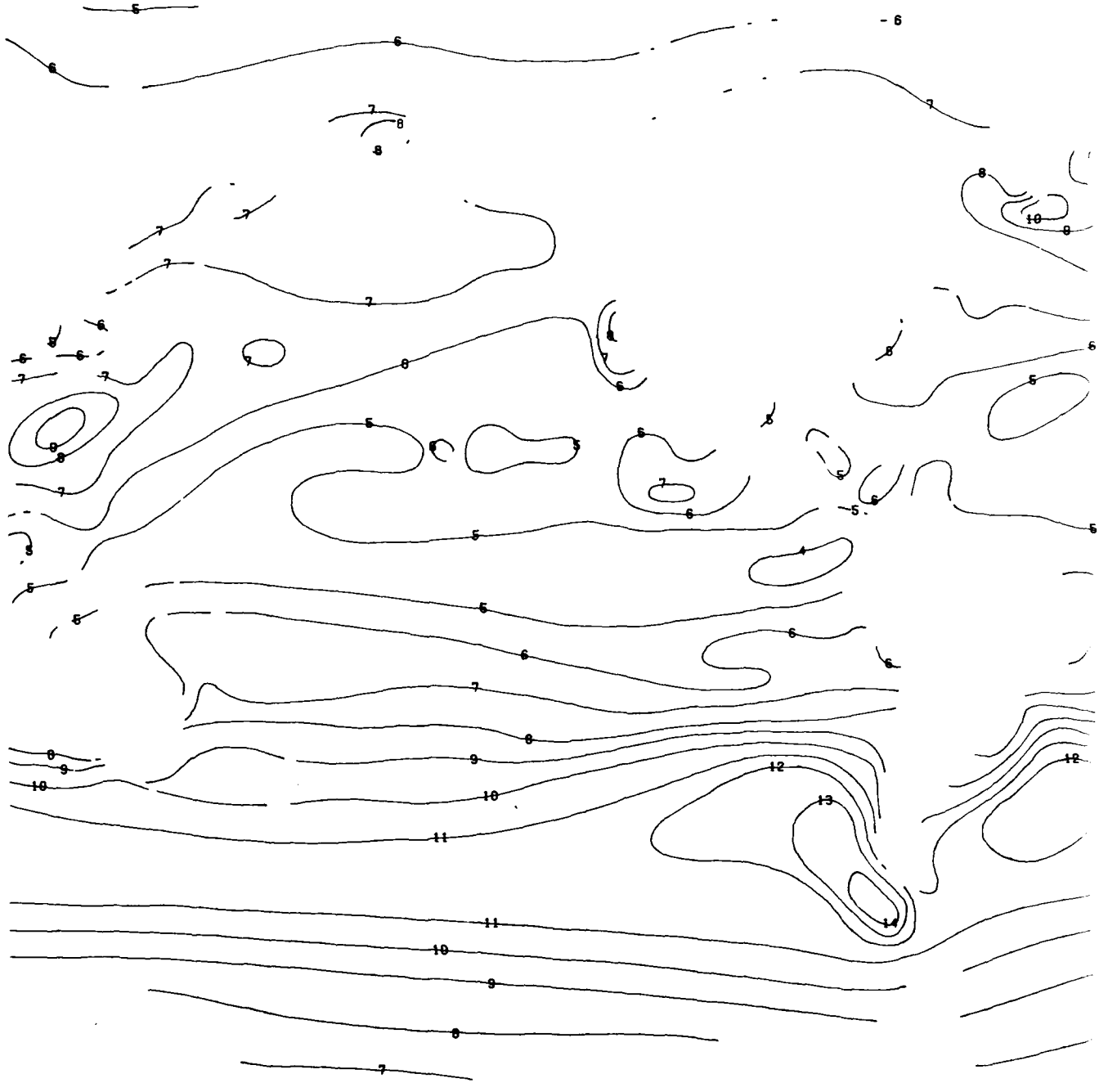
AUGUST



SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



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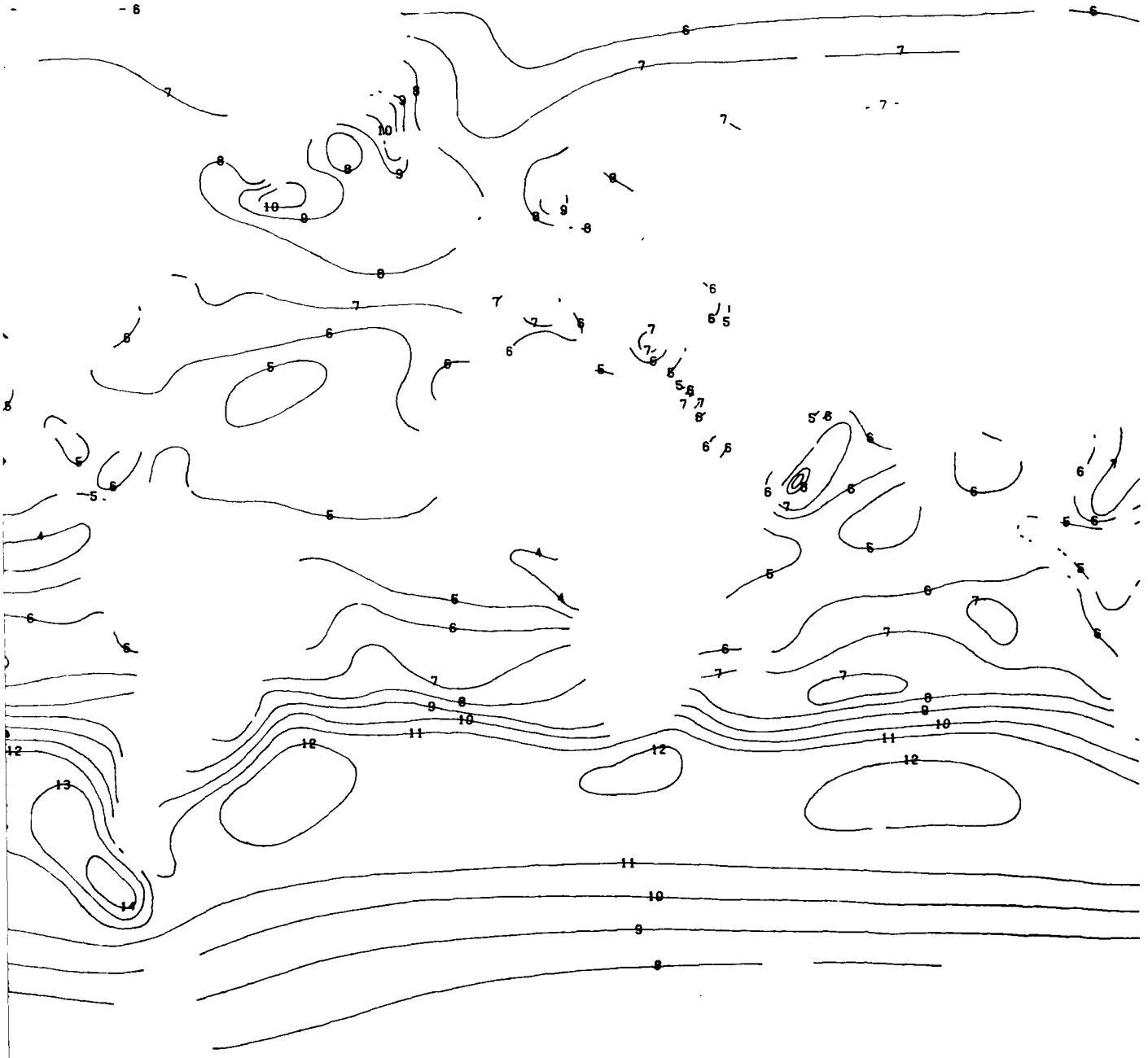

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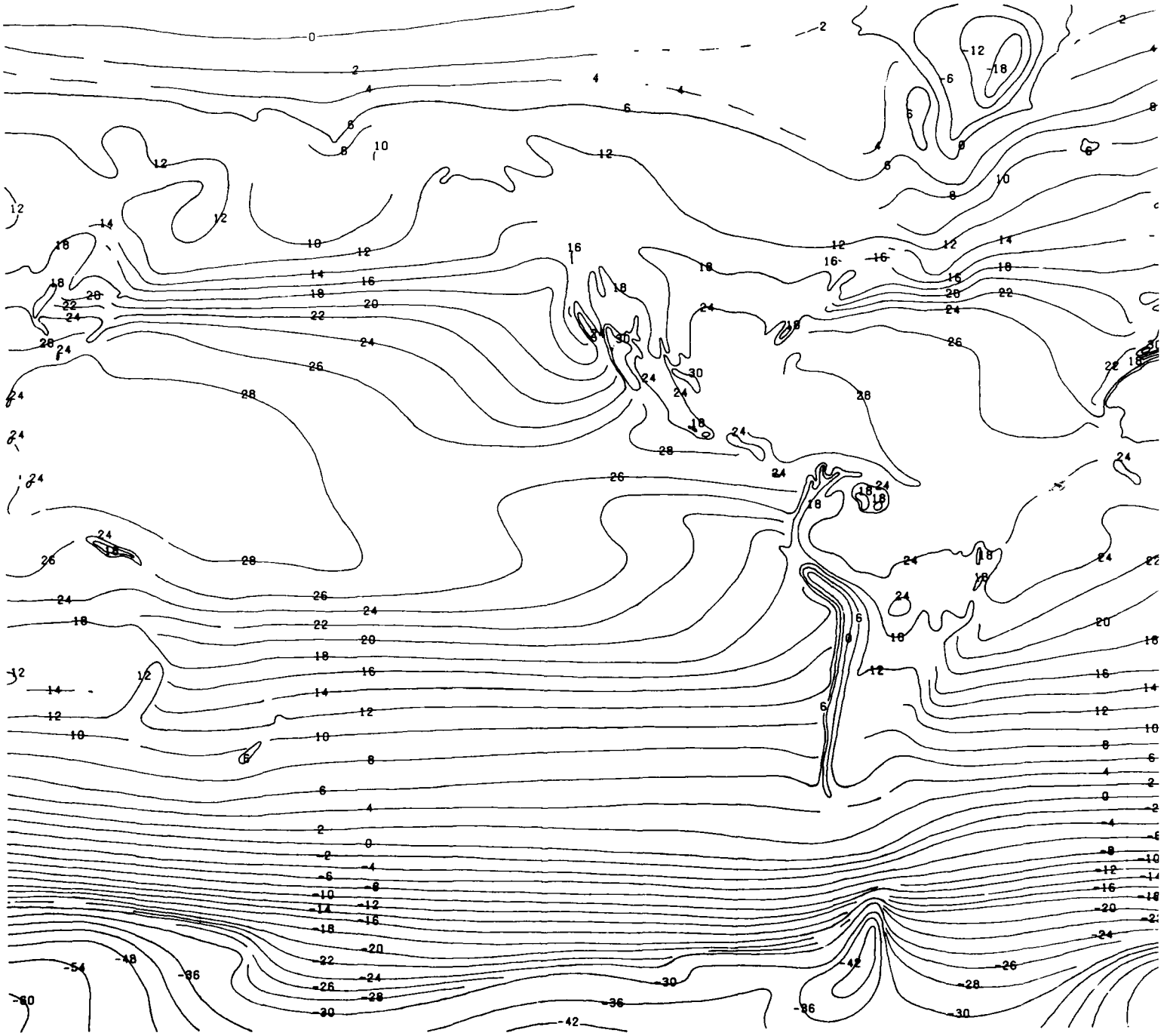
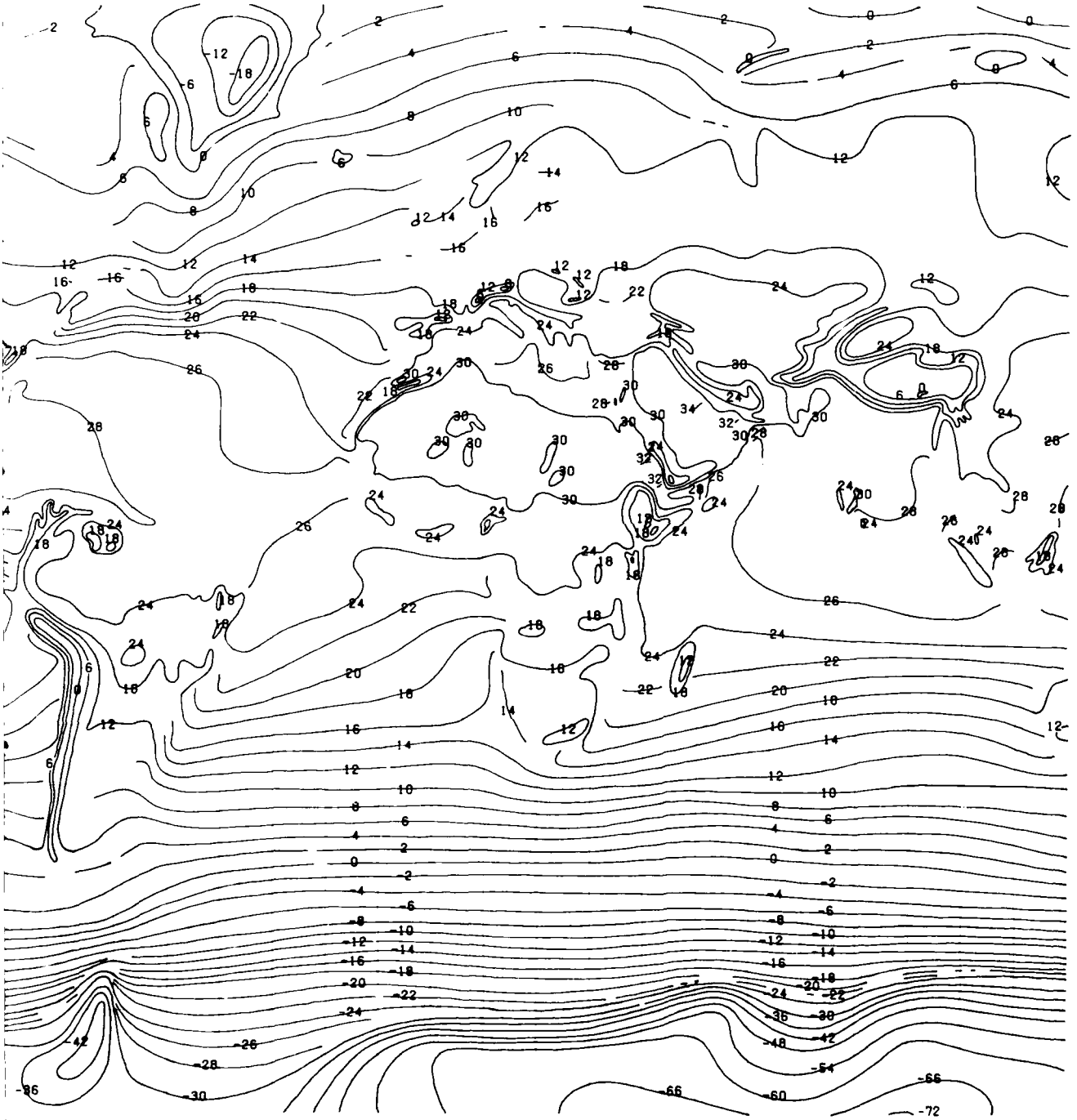
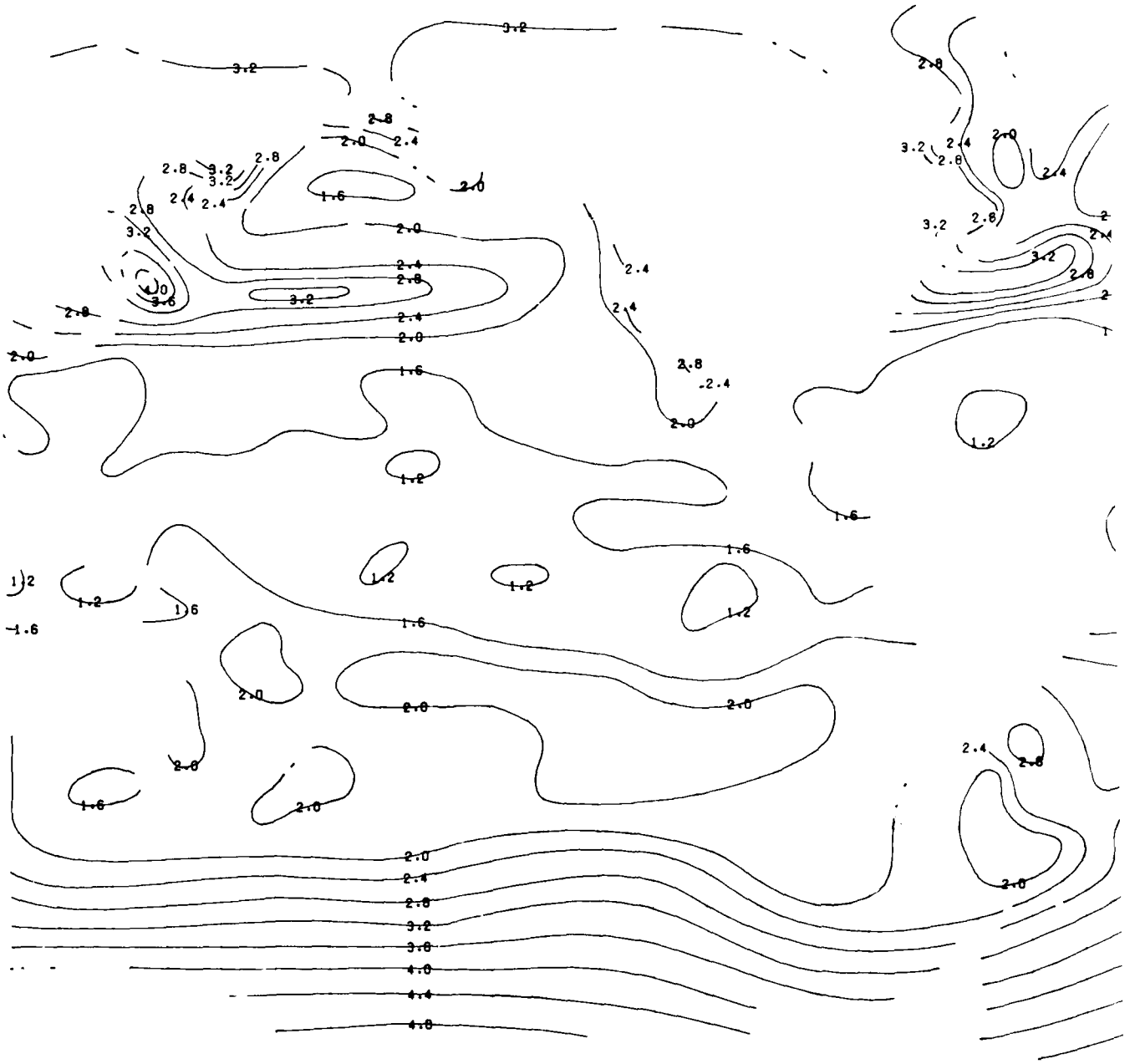


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



ARD DEVIATIONS

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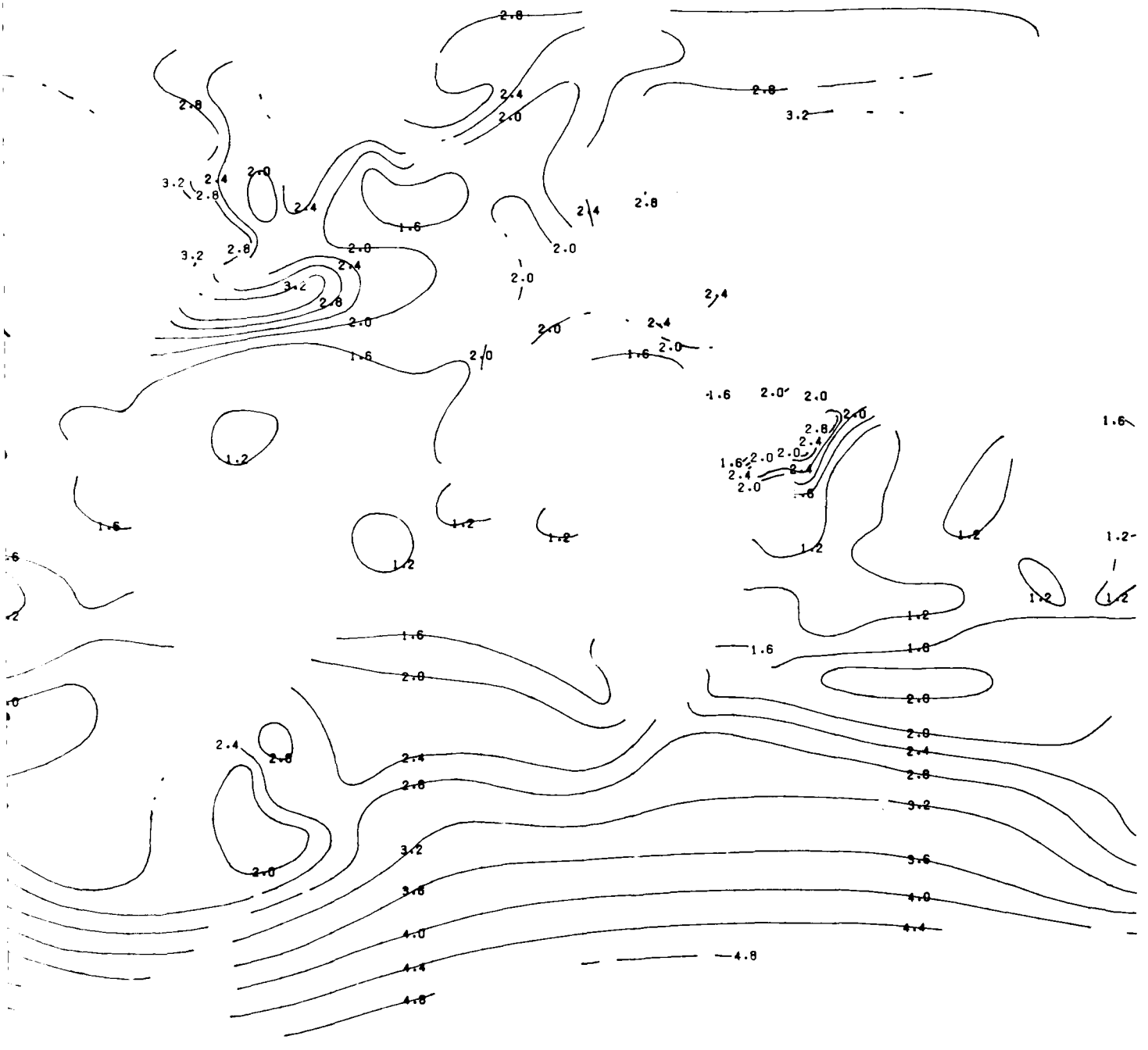

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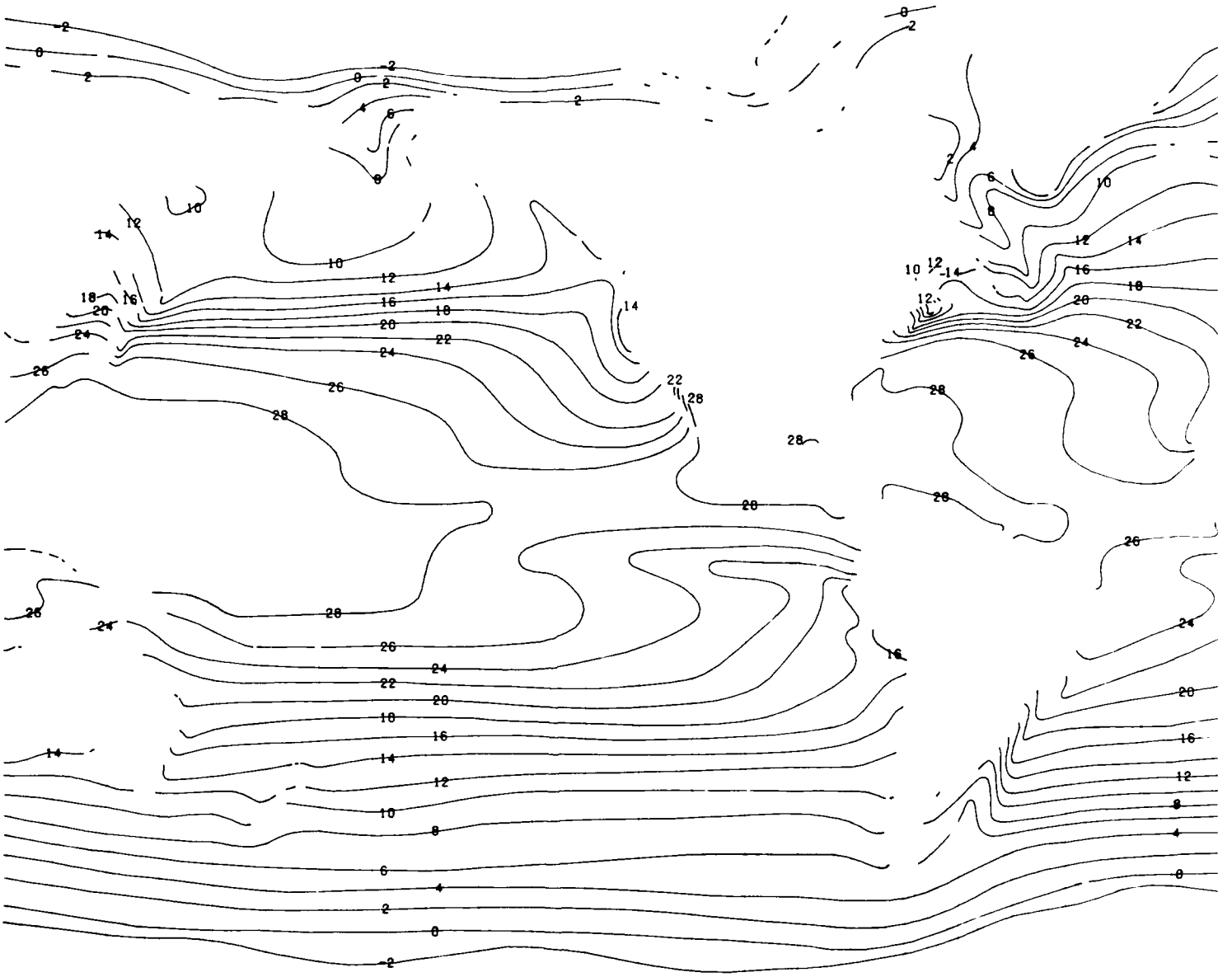
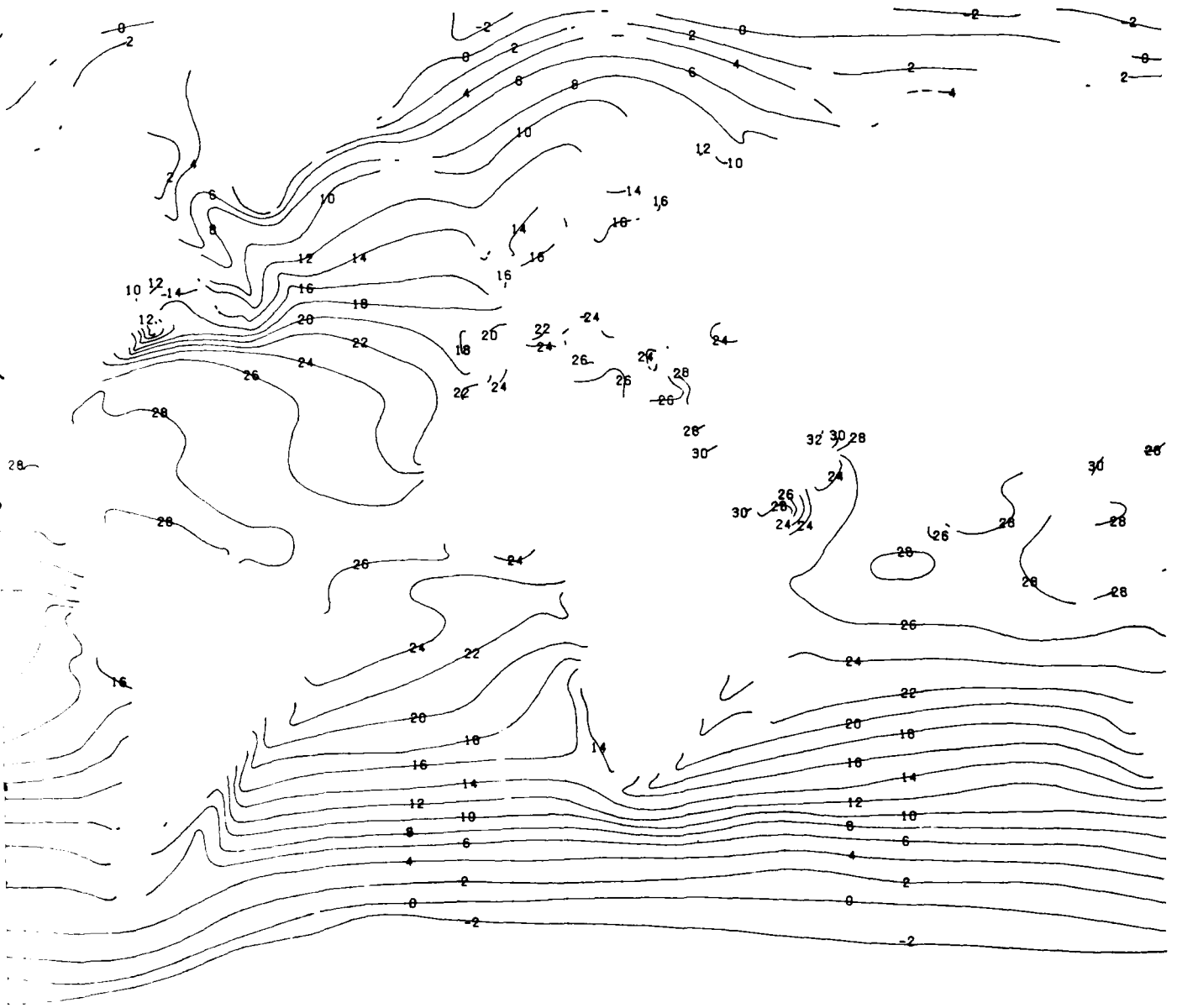
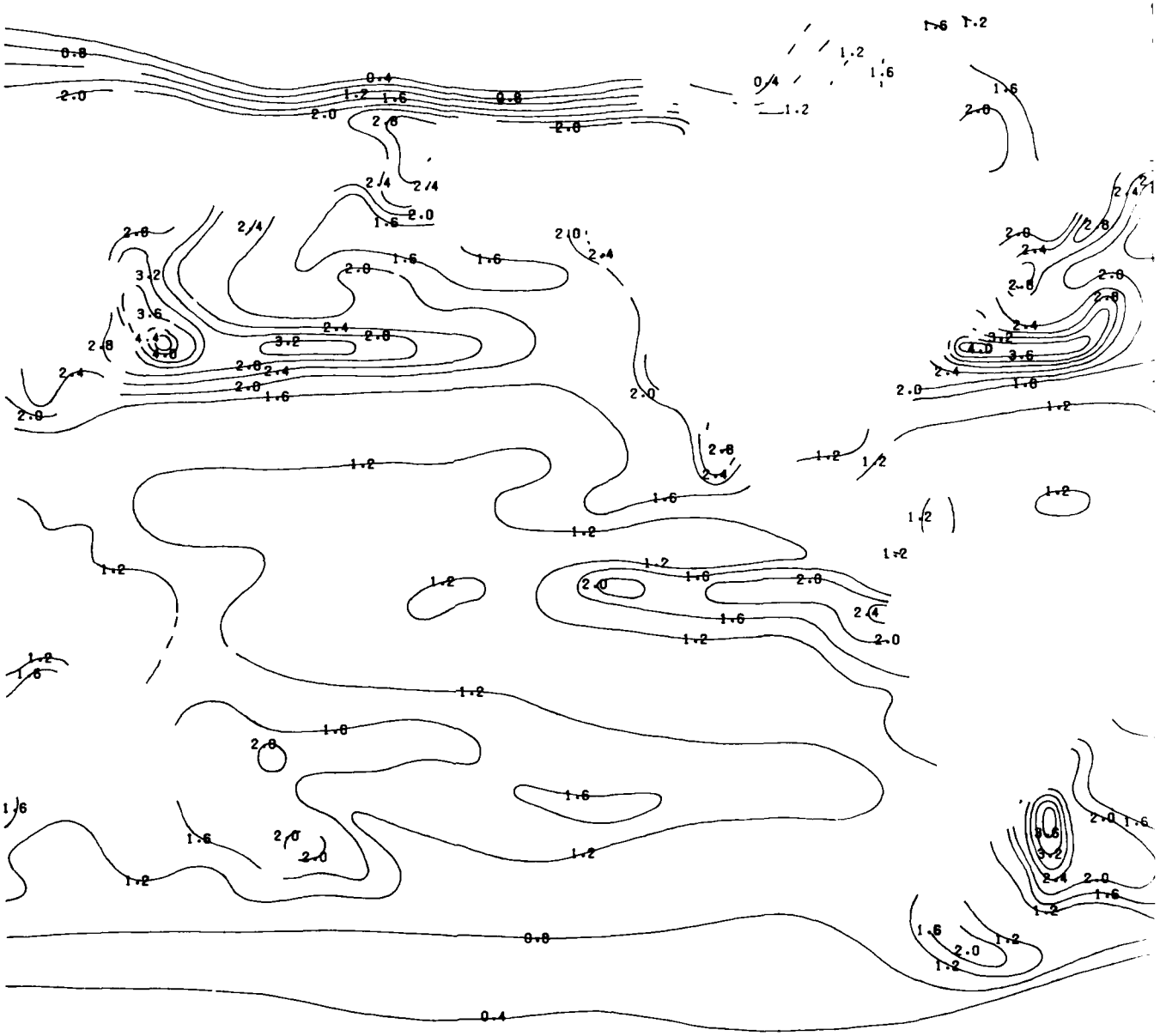


SEA SURFACE TEMPERATURE (°C) - MEANS

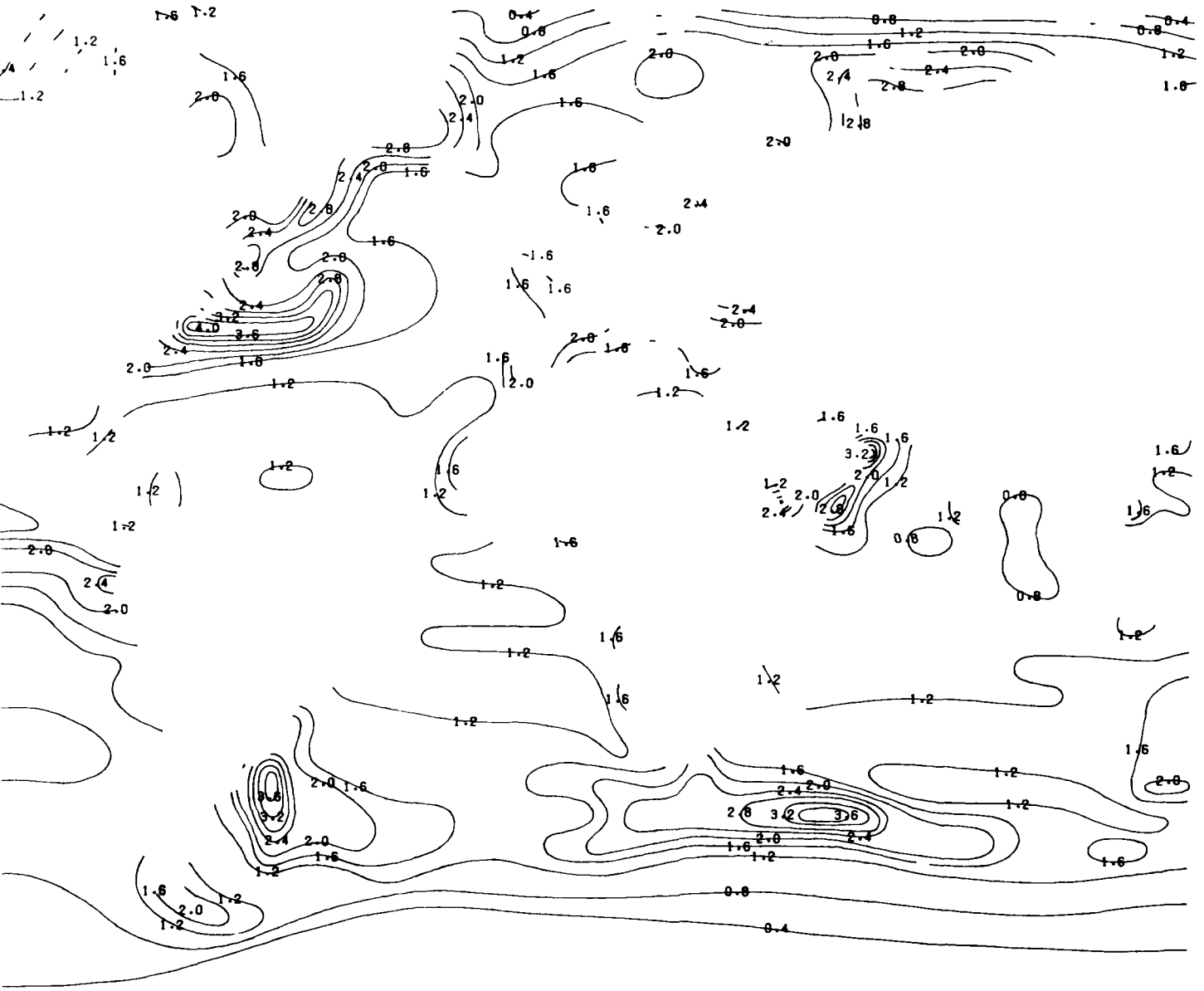


SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



DARD DEVIATIONS

AUGUST



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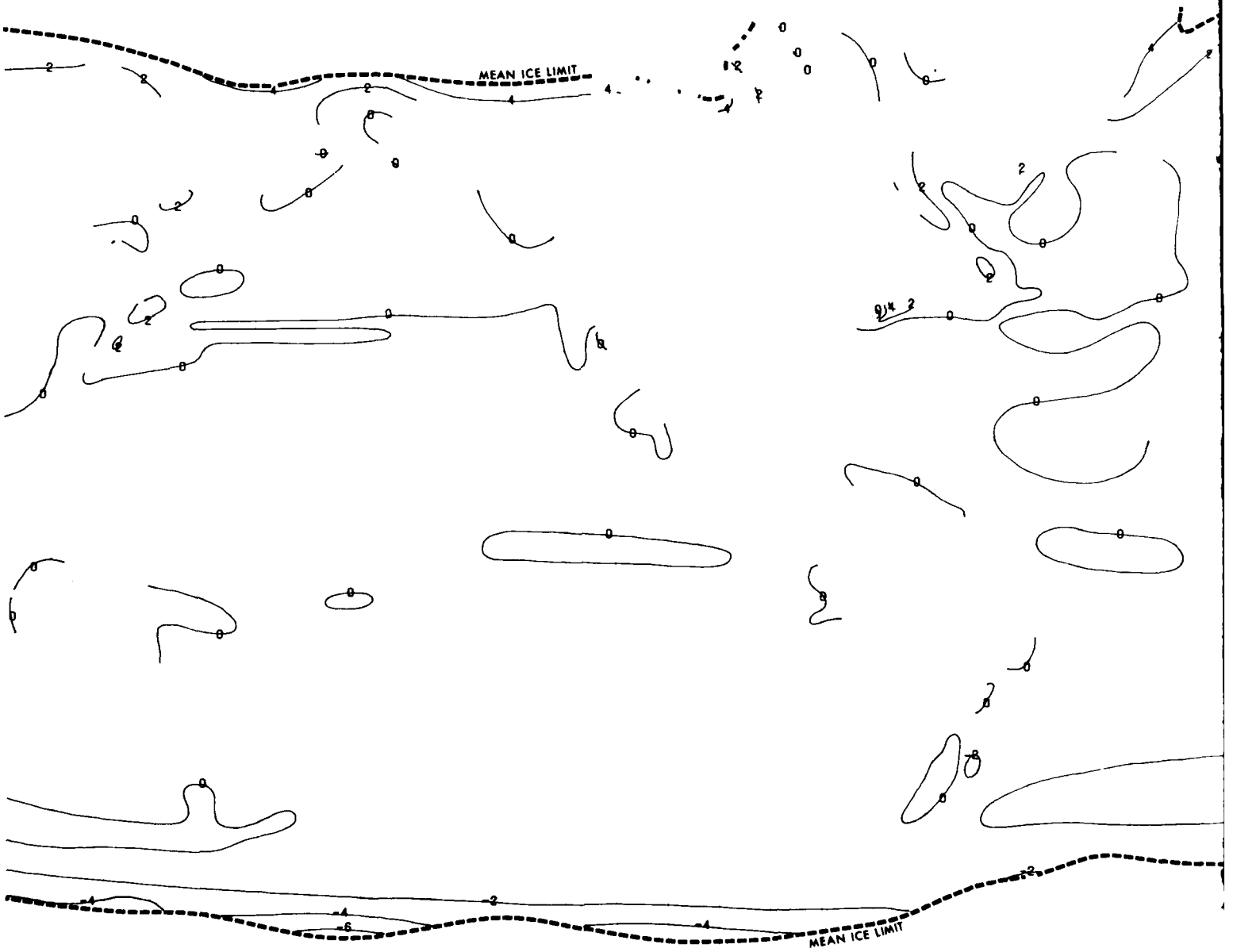
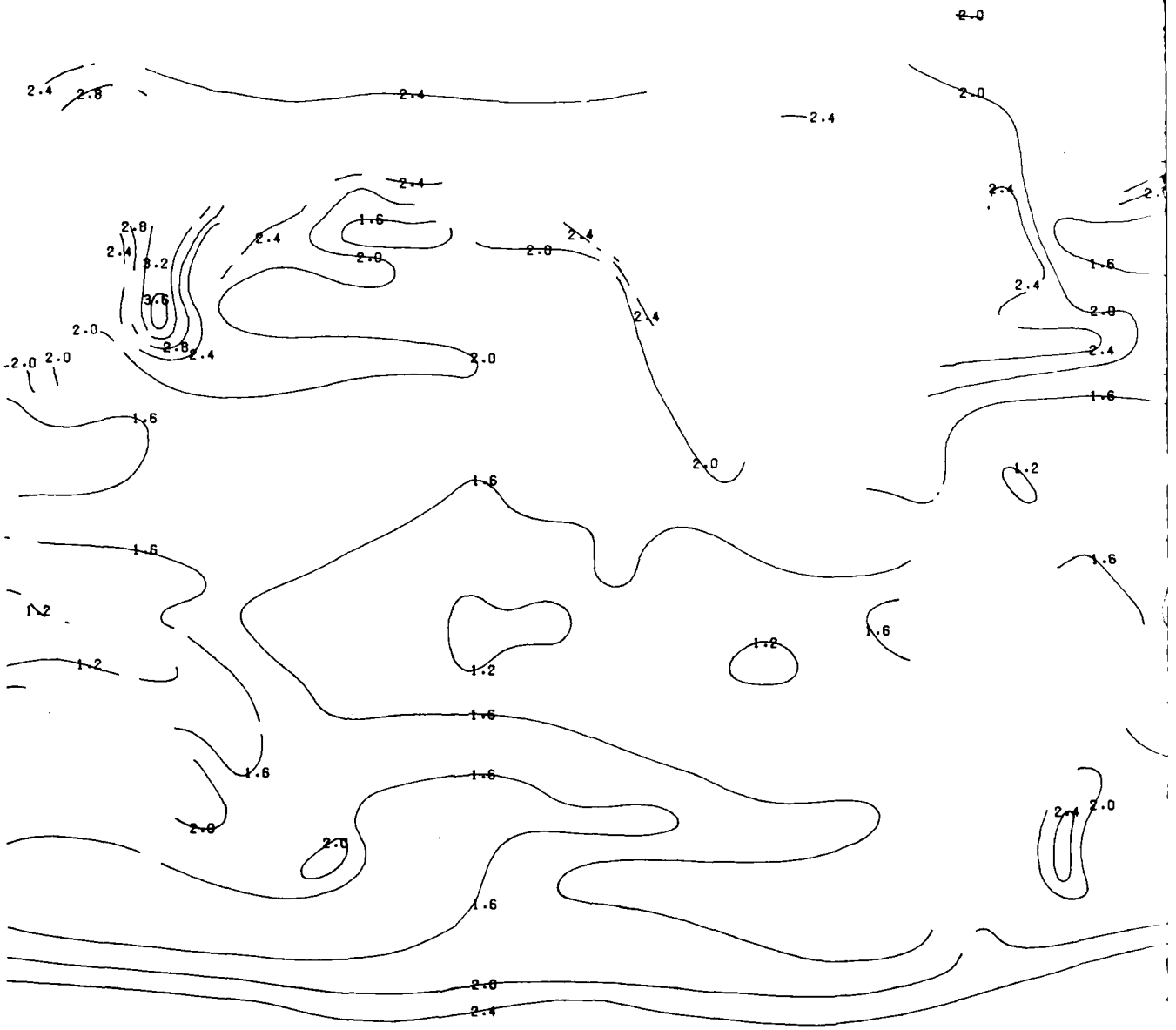
AIR-SEA TEN



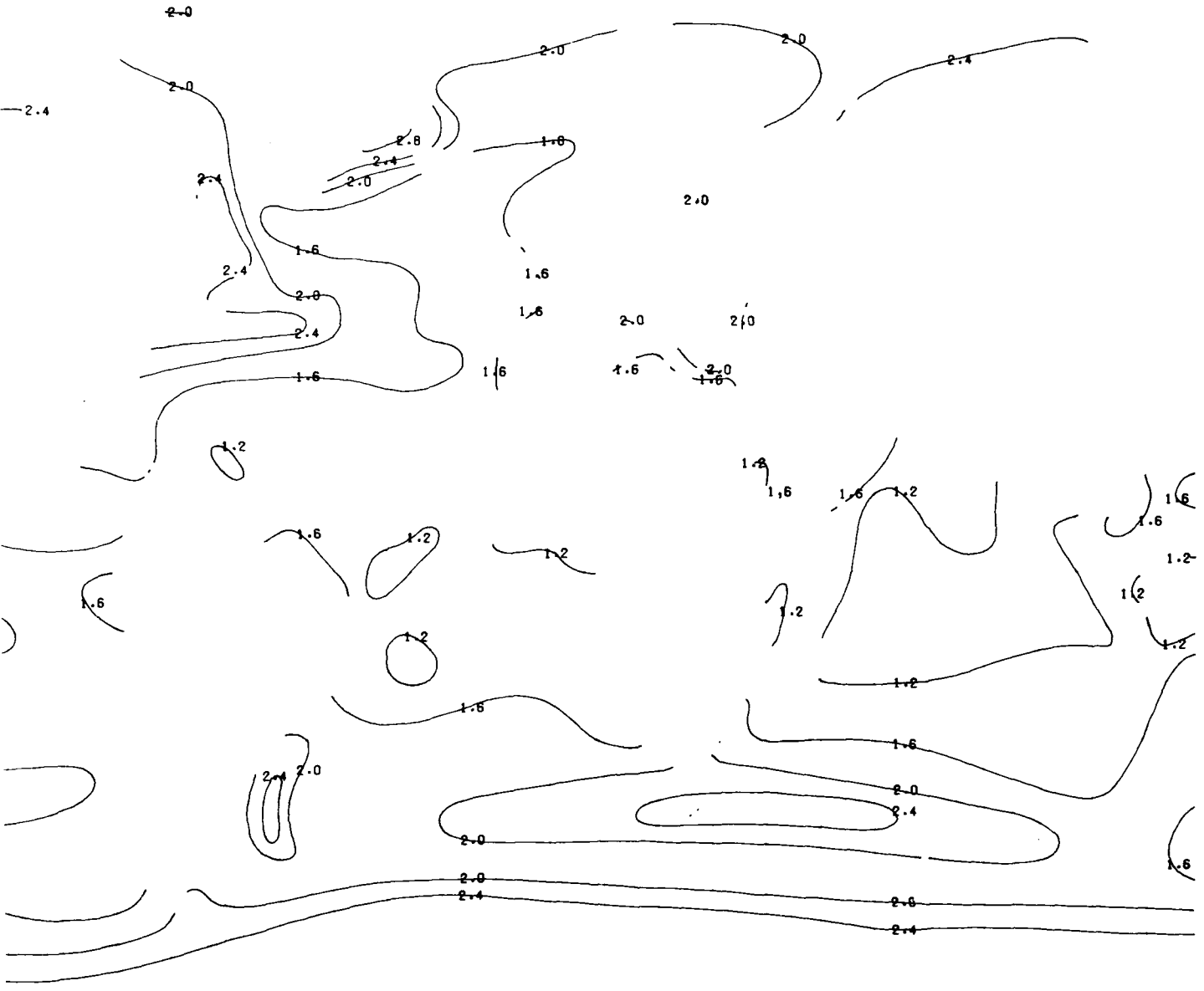
AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATION



STANDARD DEVIATIONS

AUGUST



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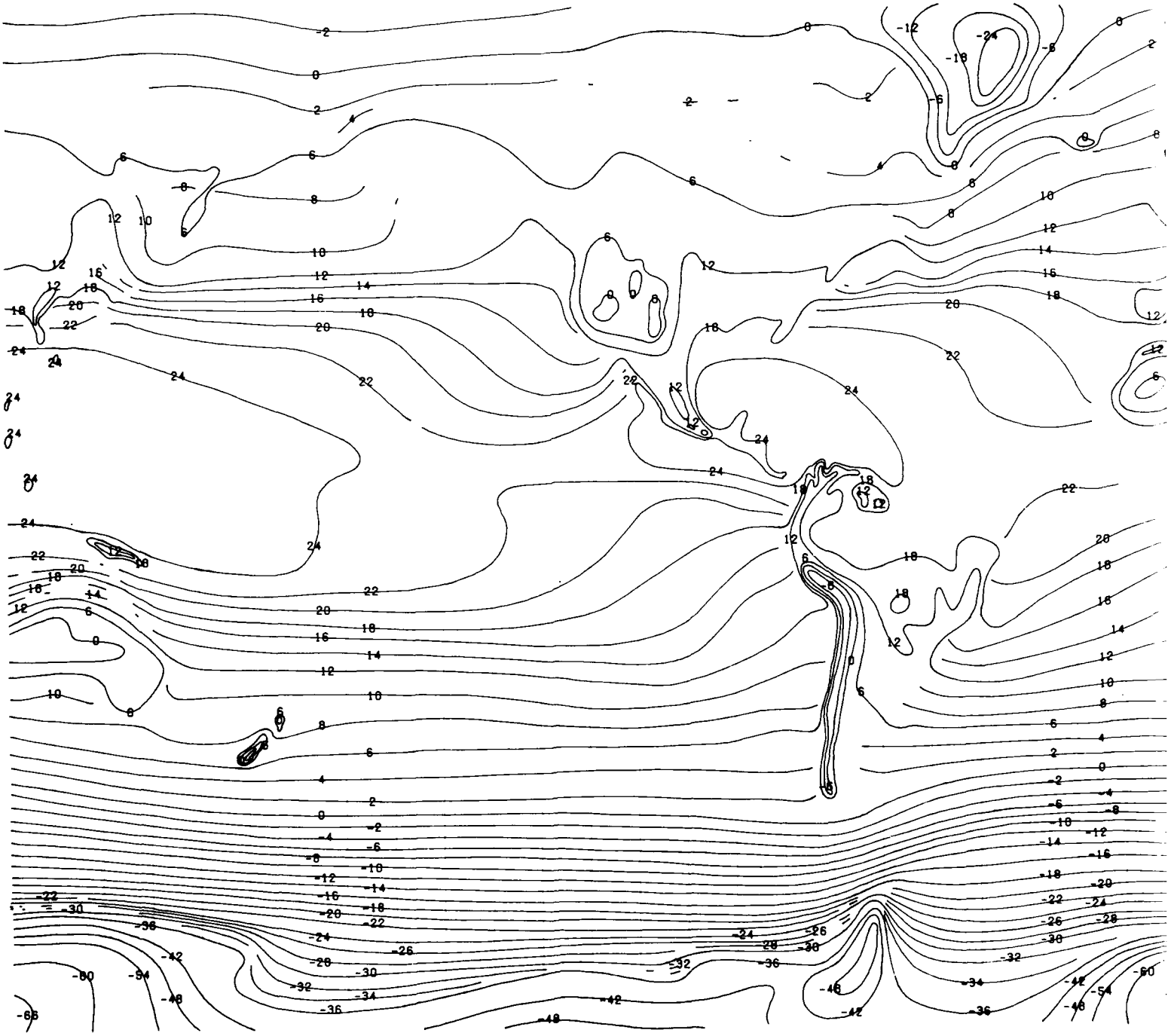
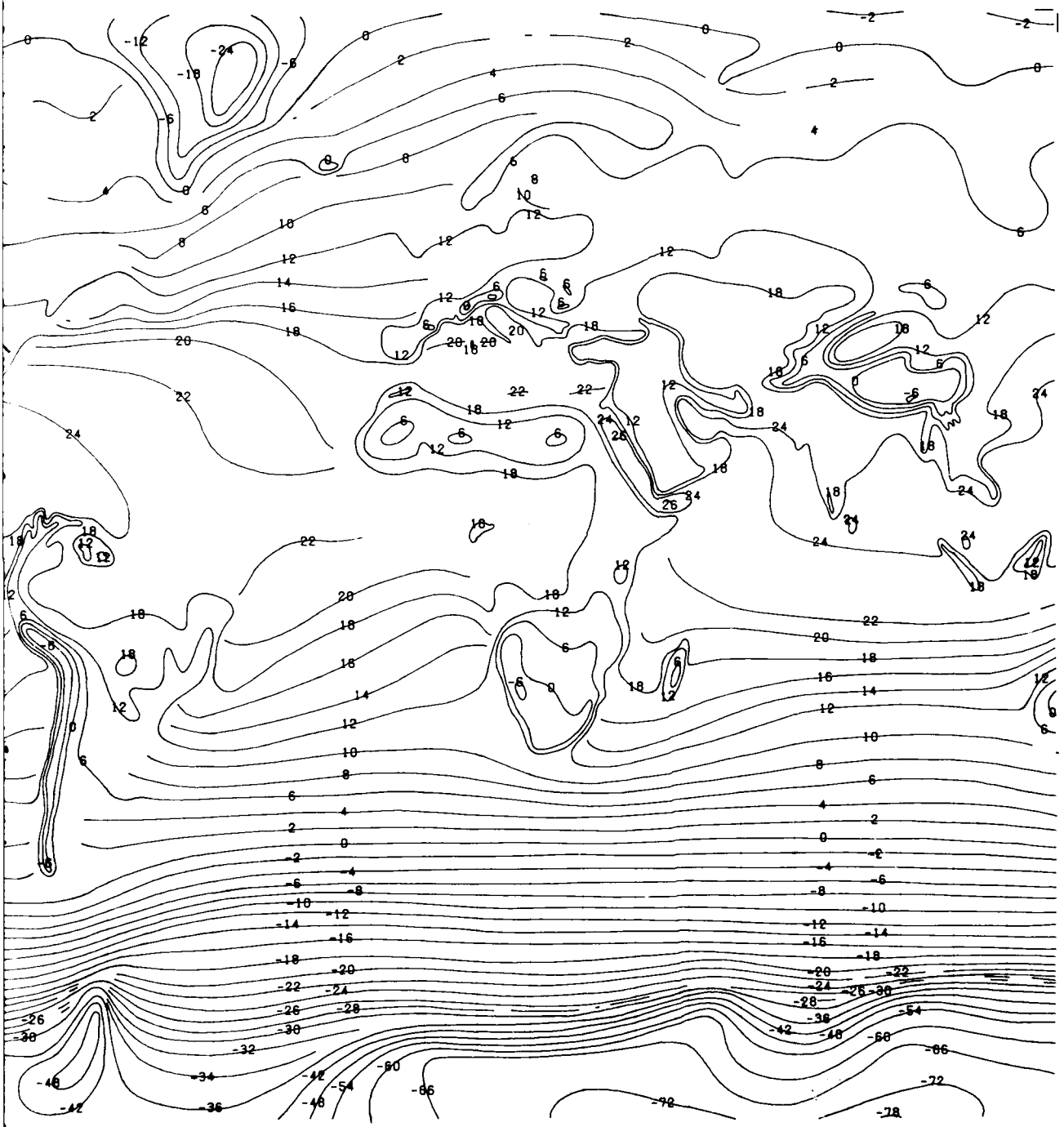
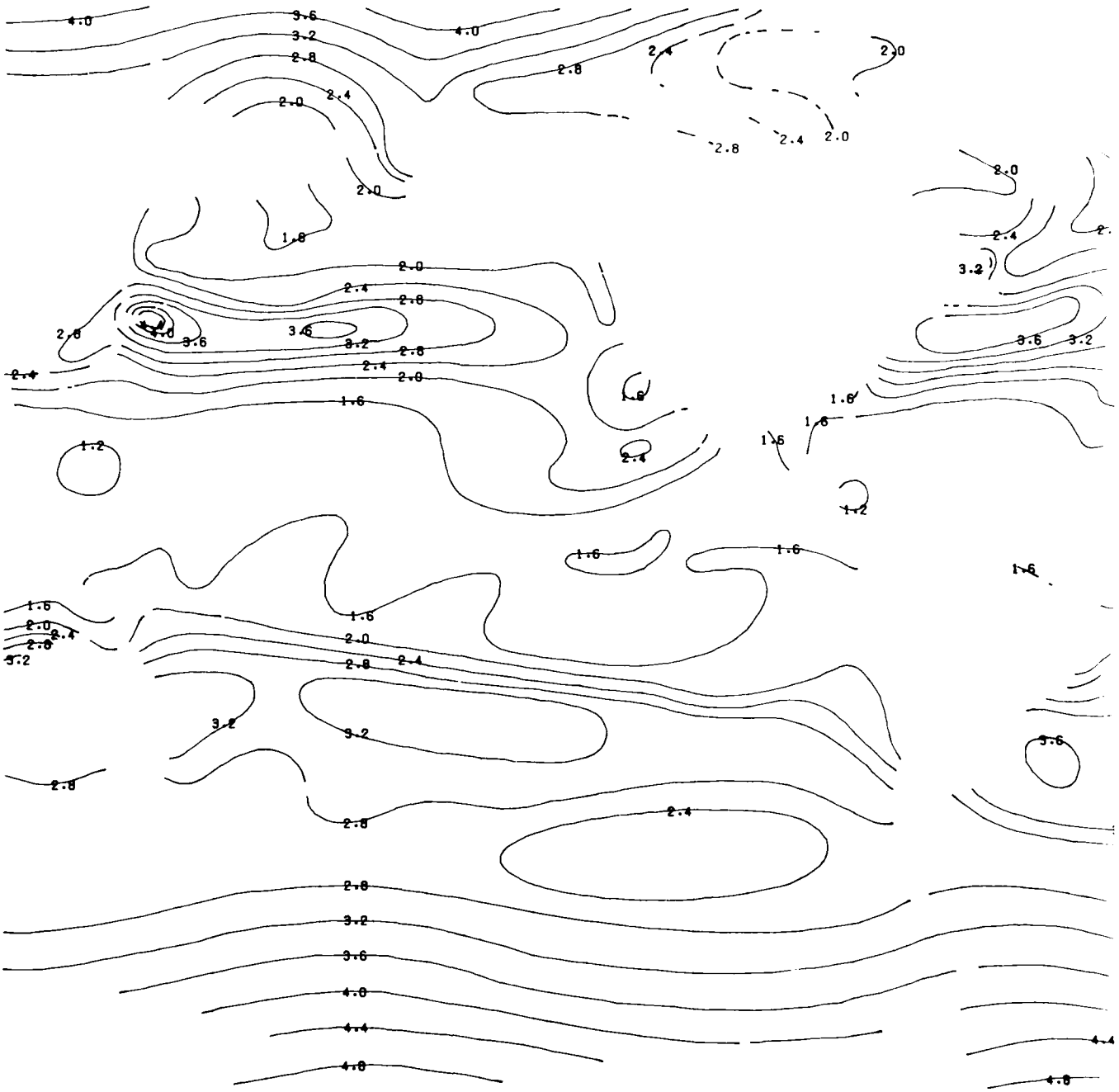
AUGUST



DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



DARD DEVIATIONS

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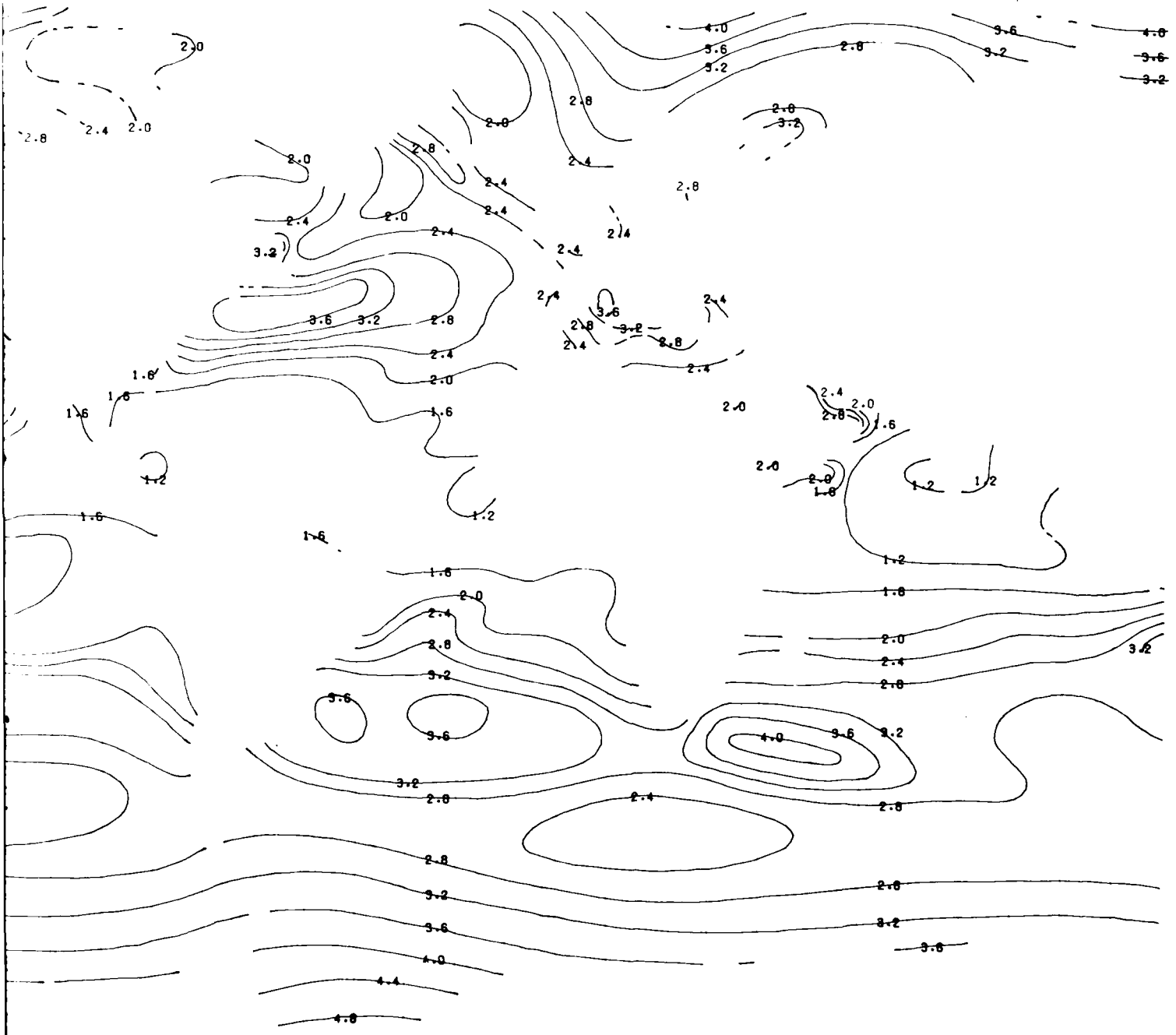

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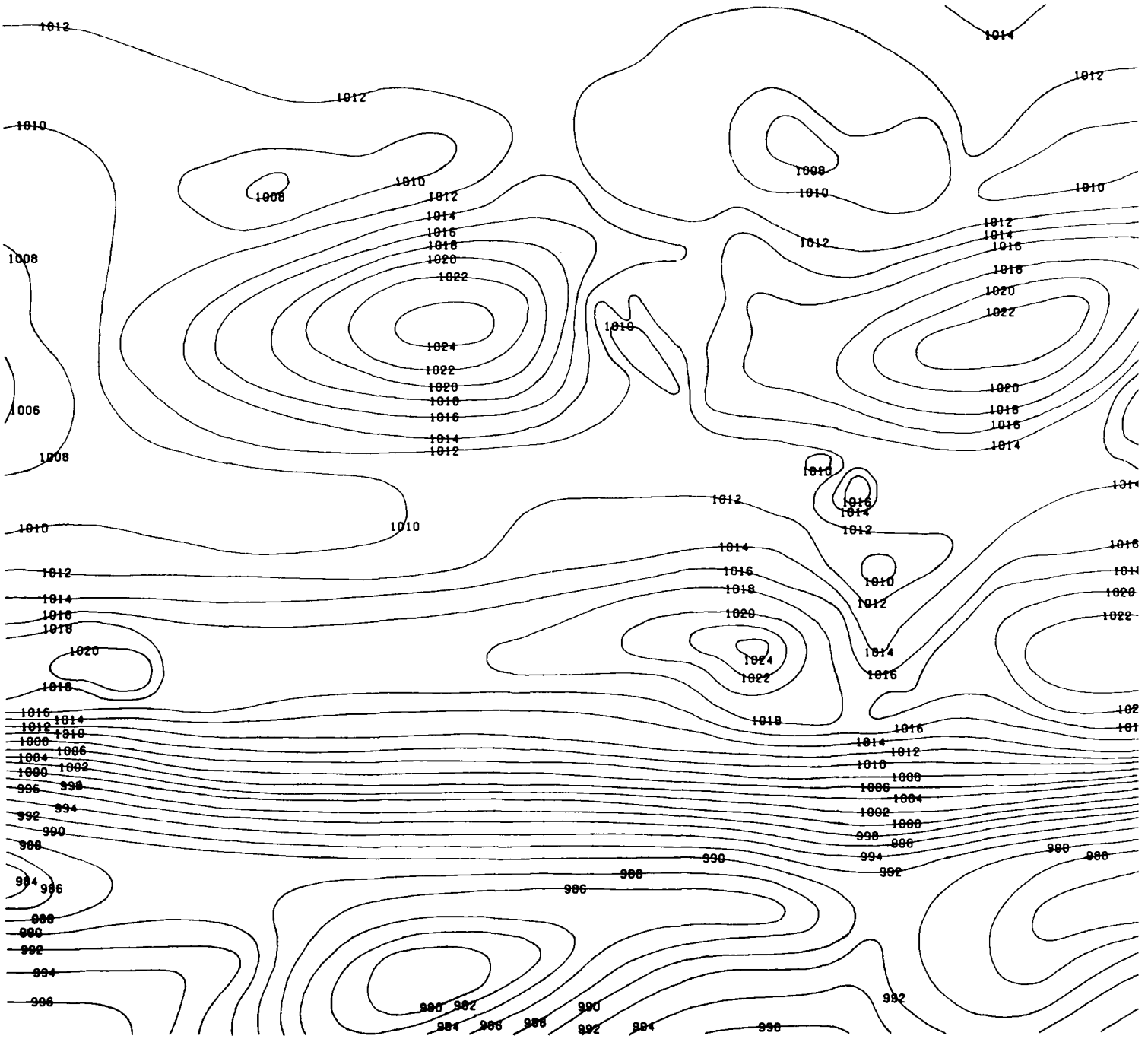
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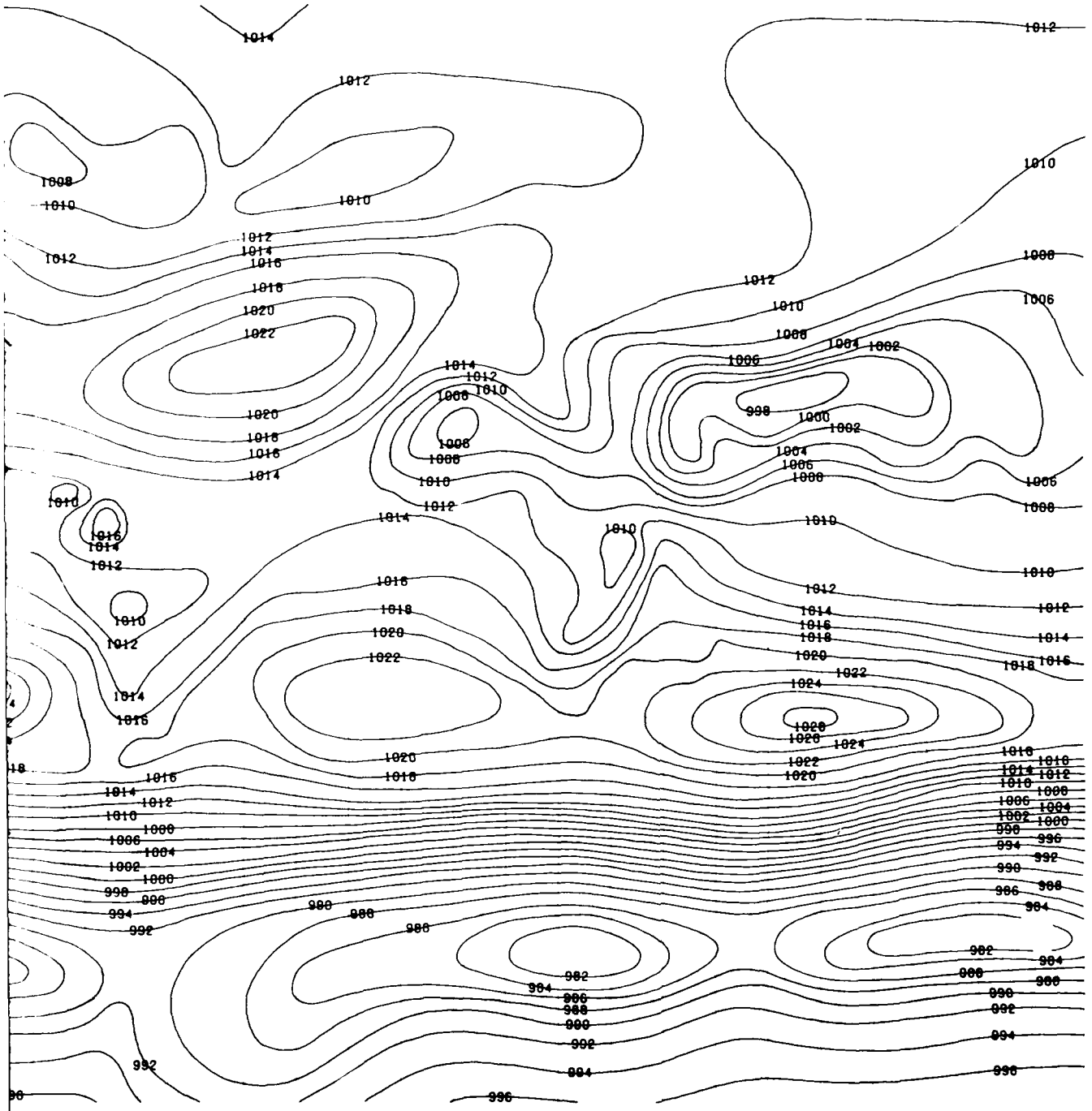
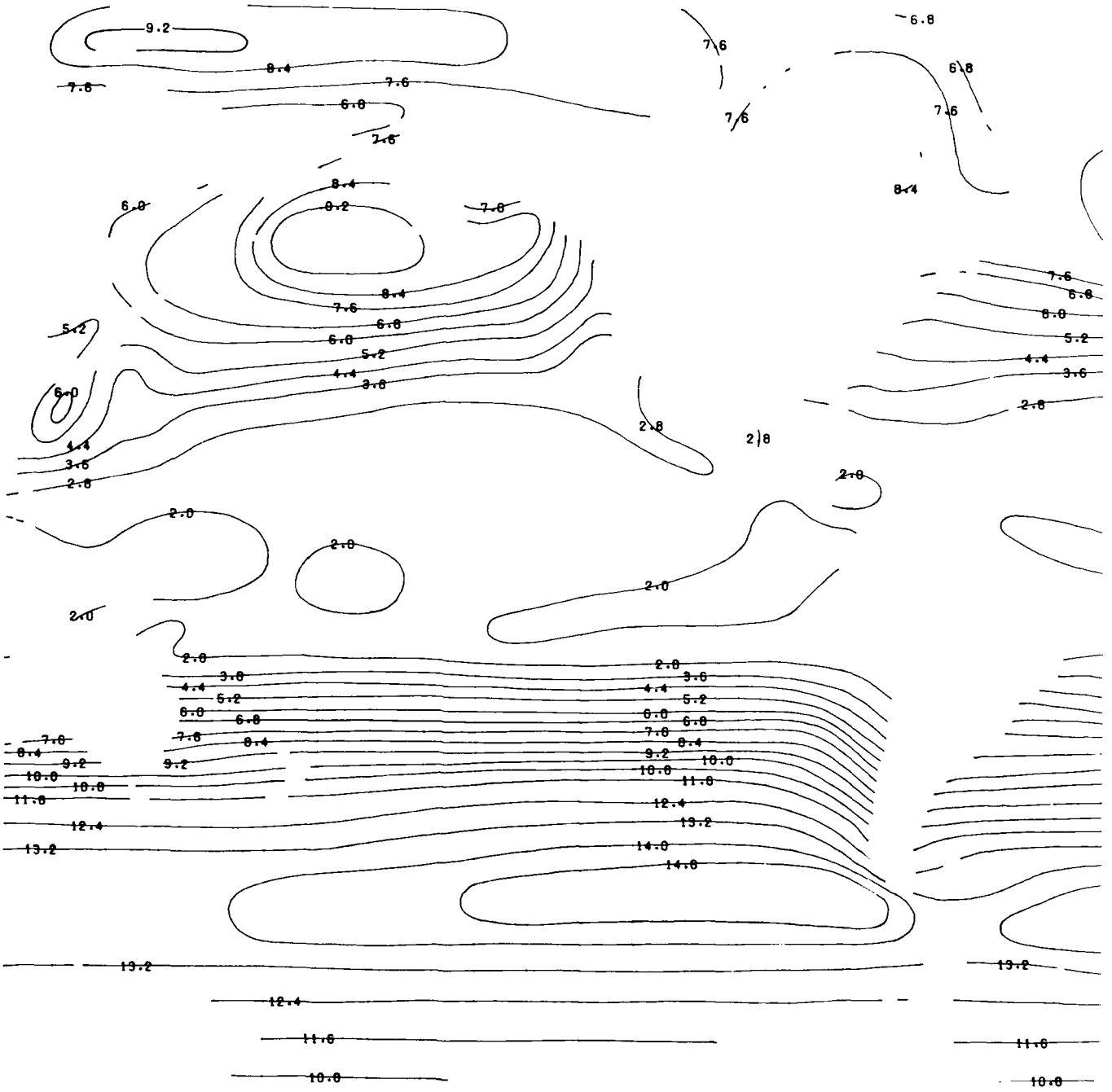
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



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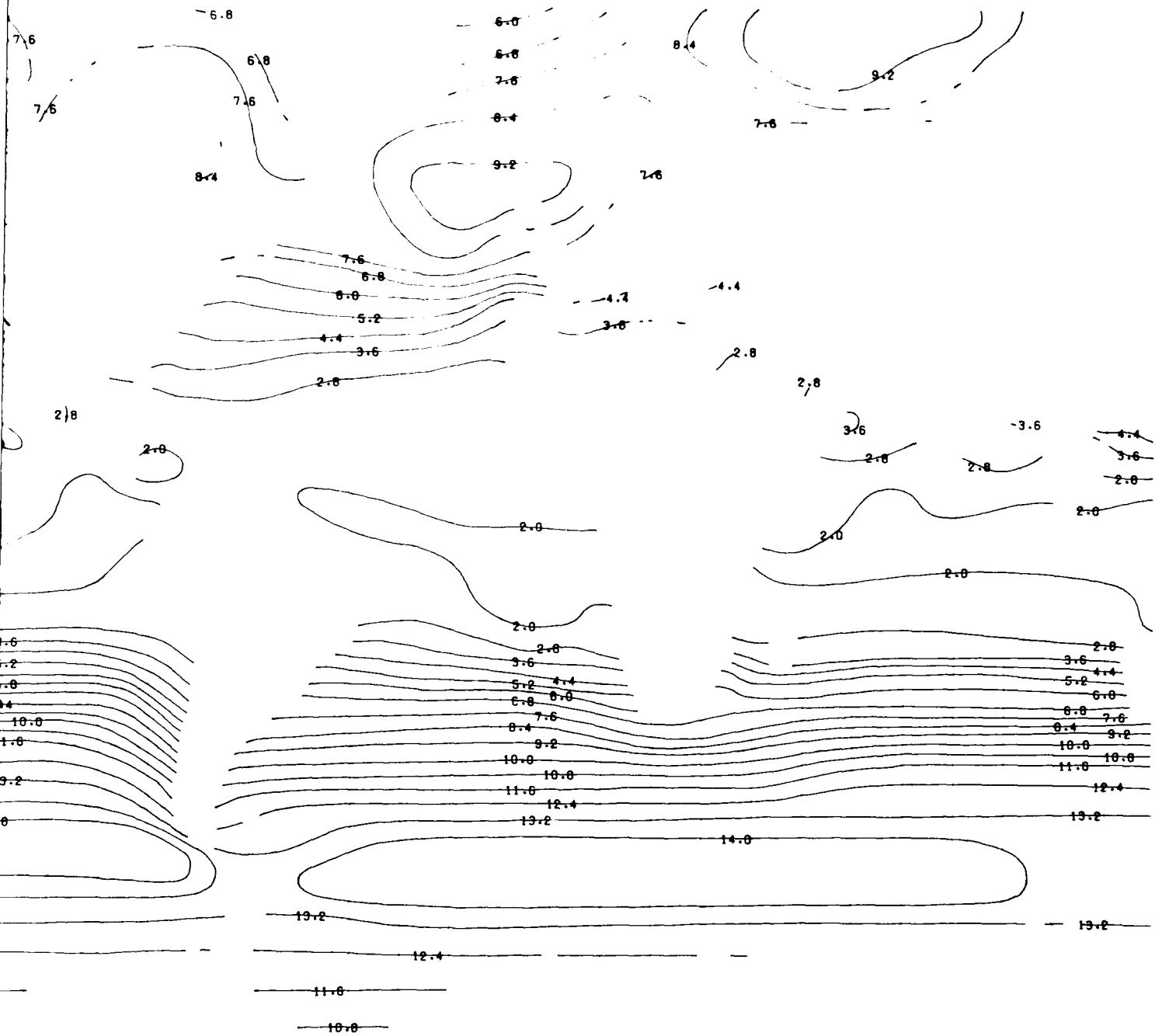

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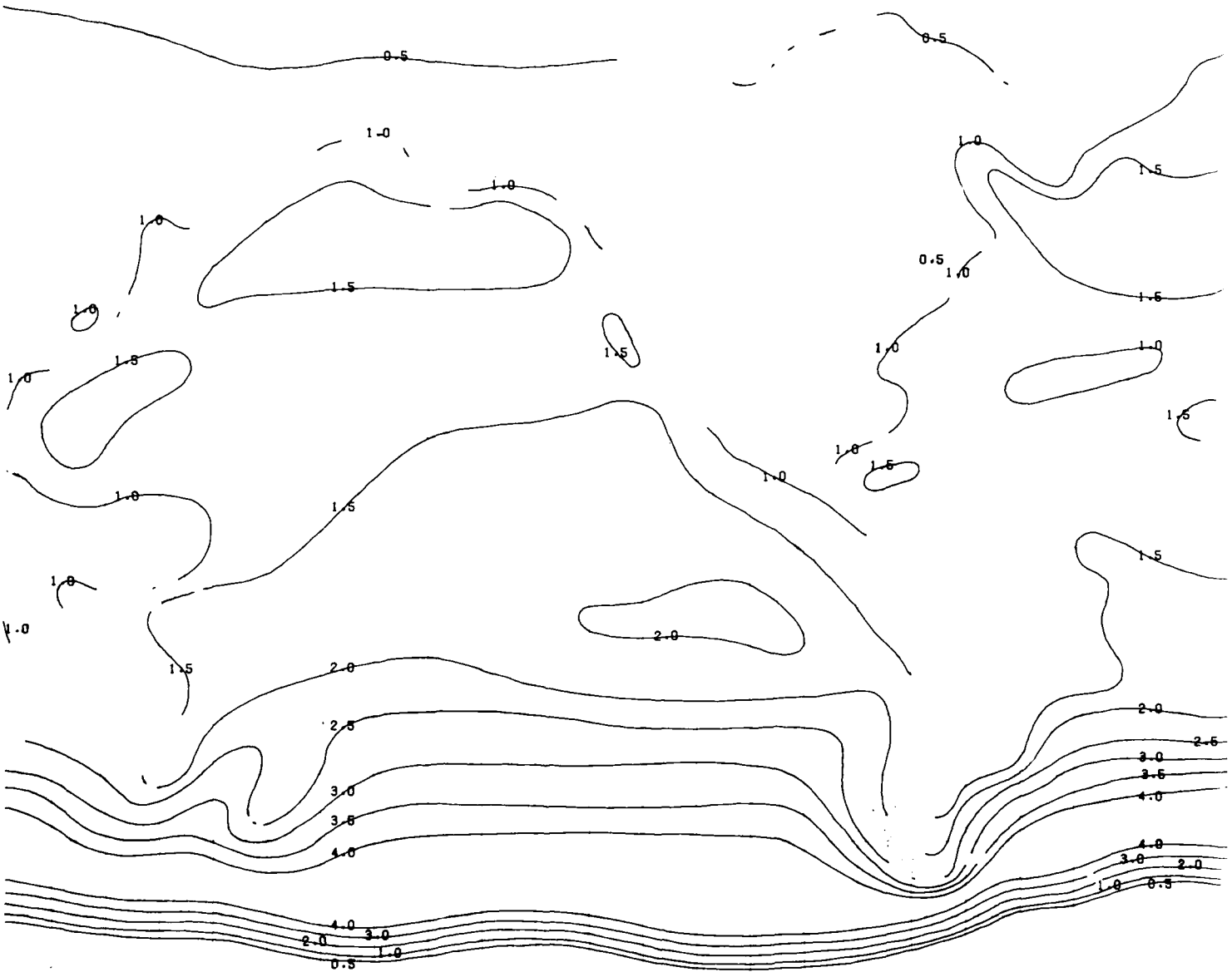
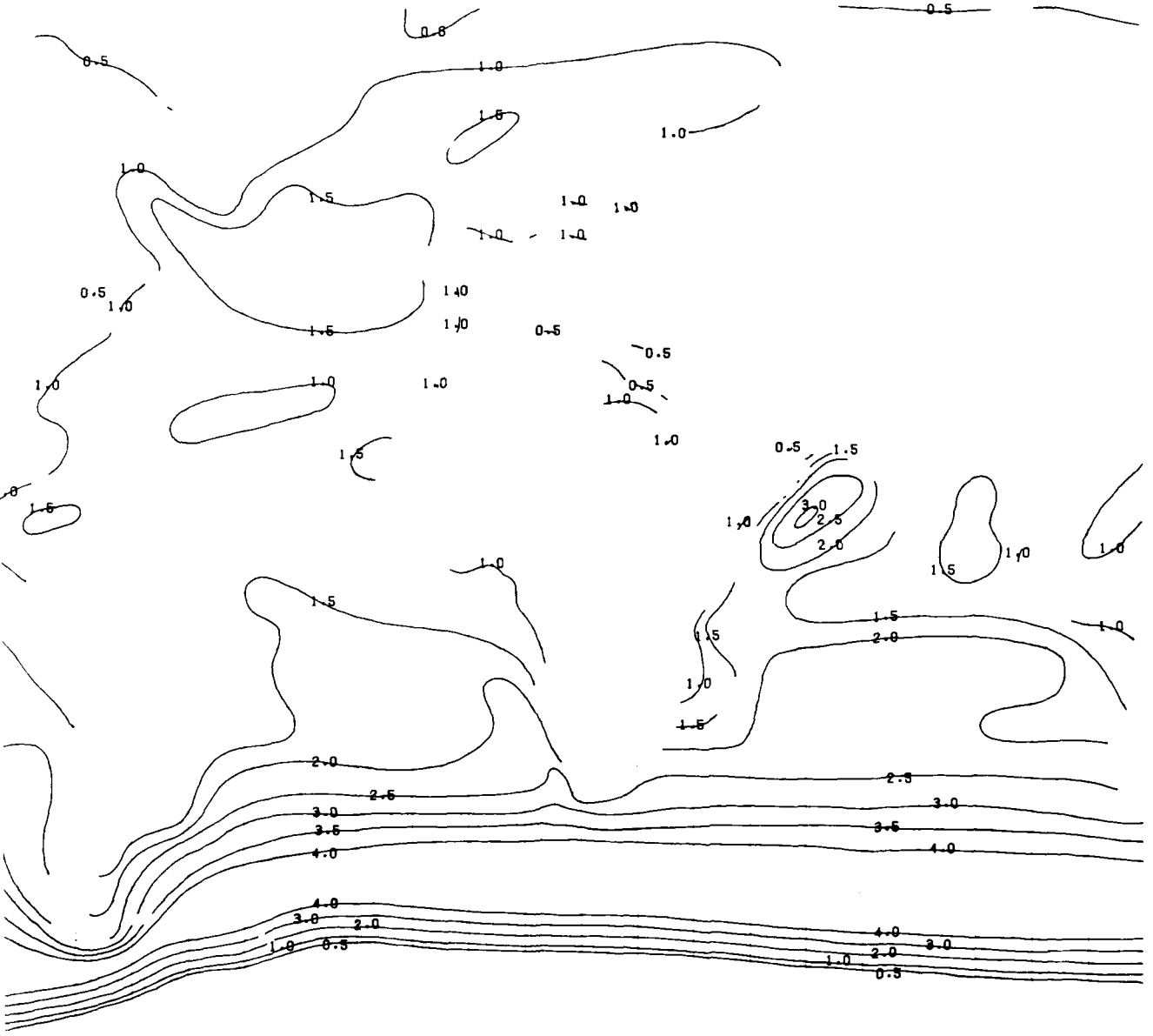
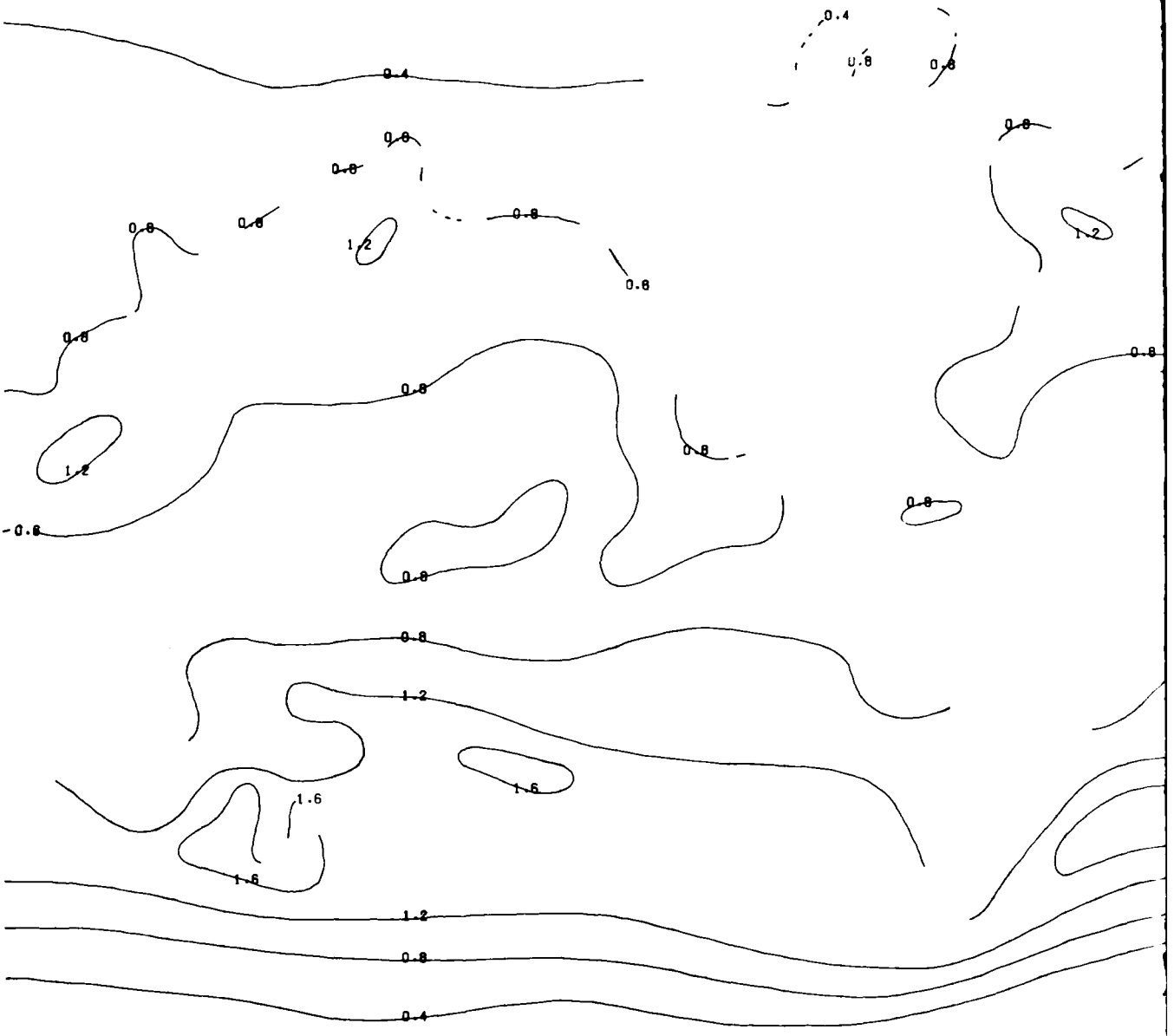


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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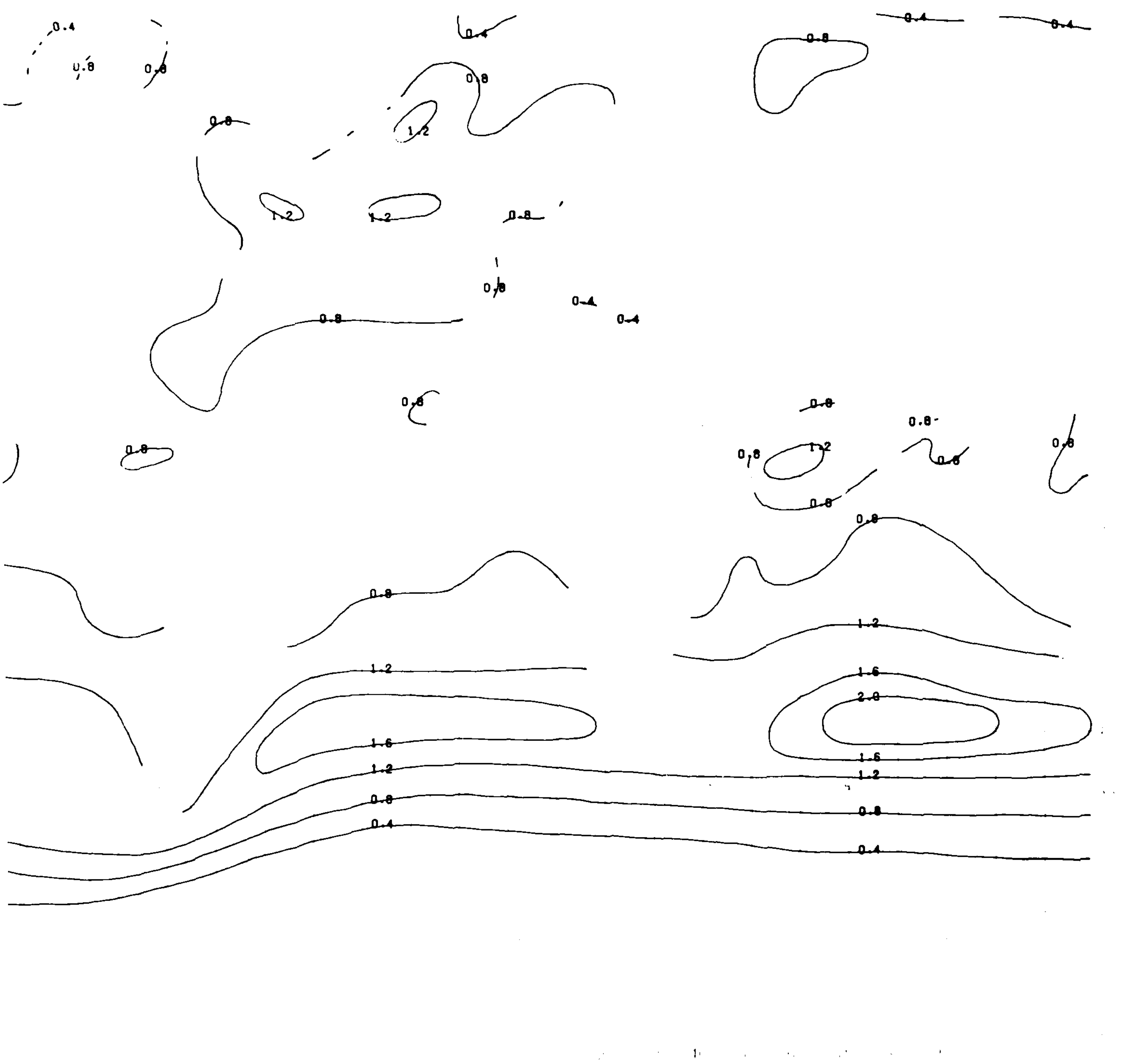

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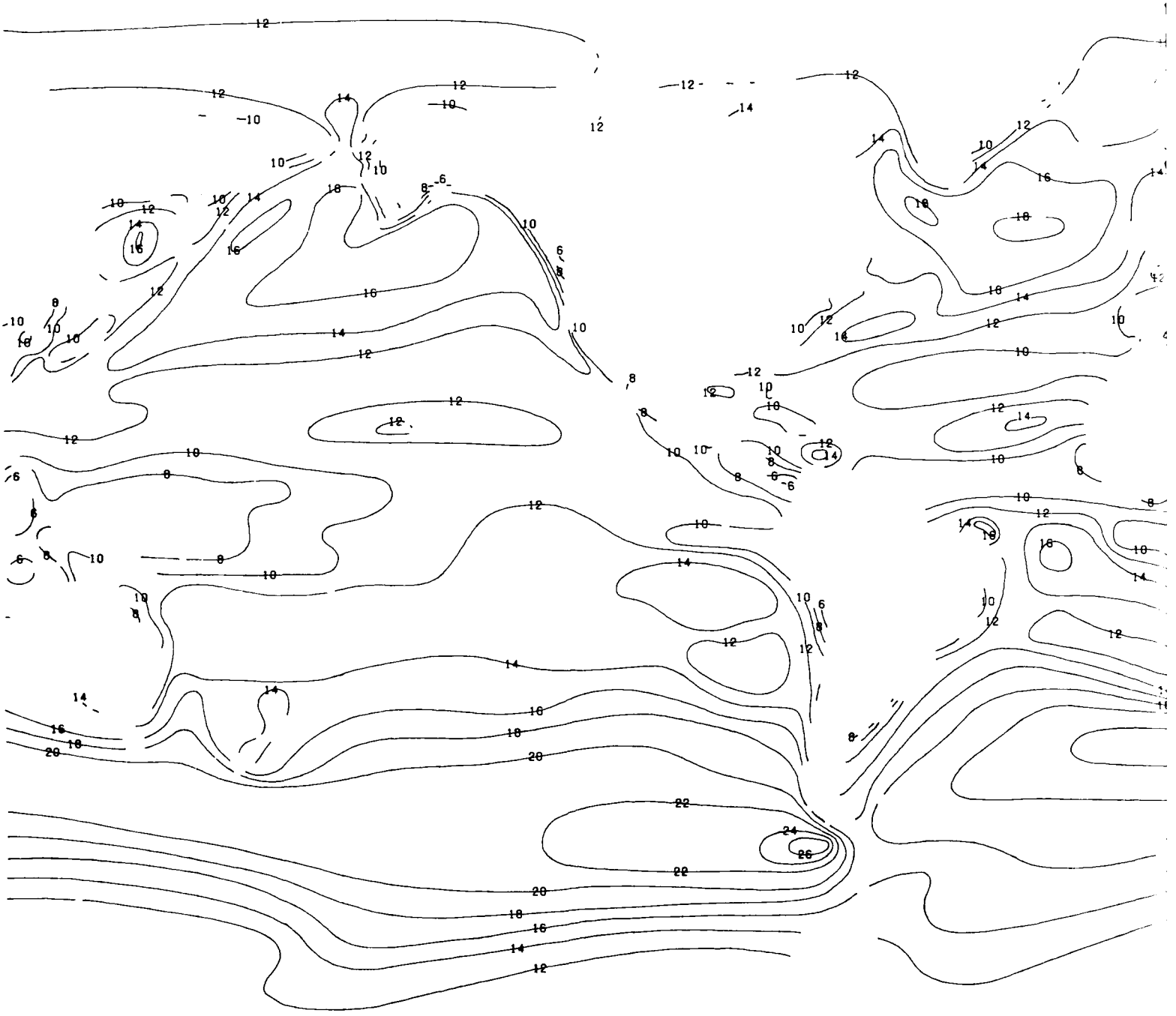
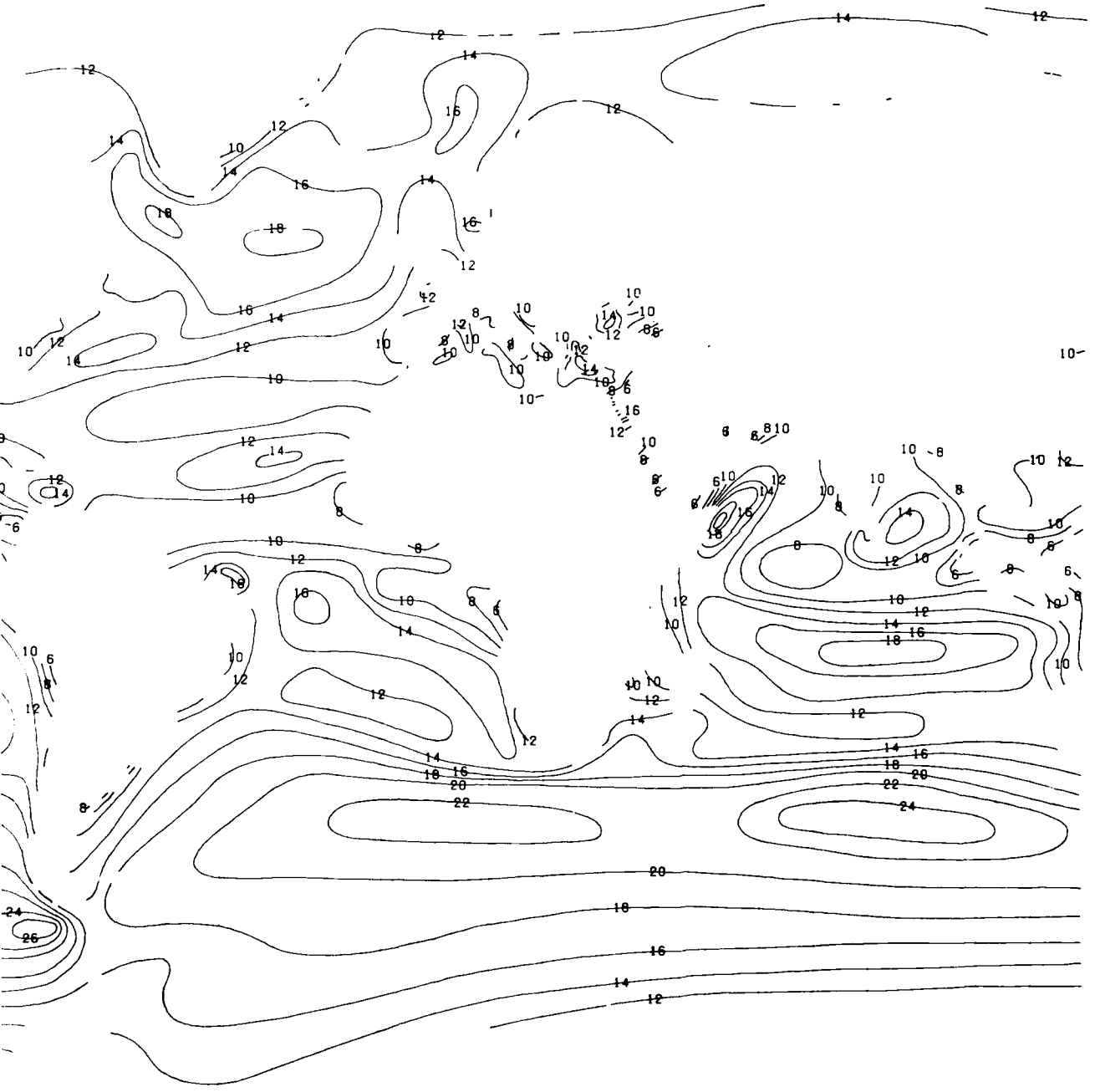
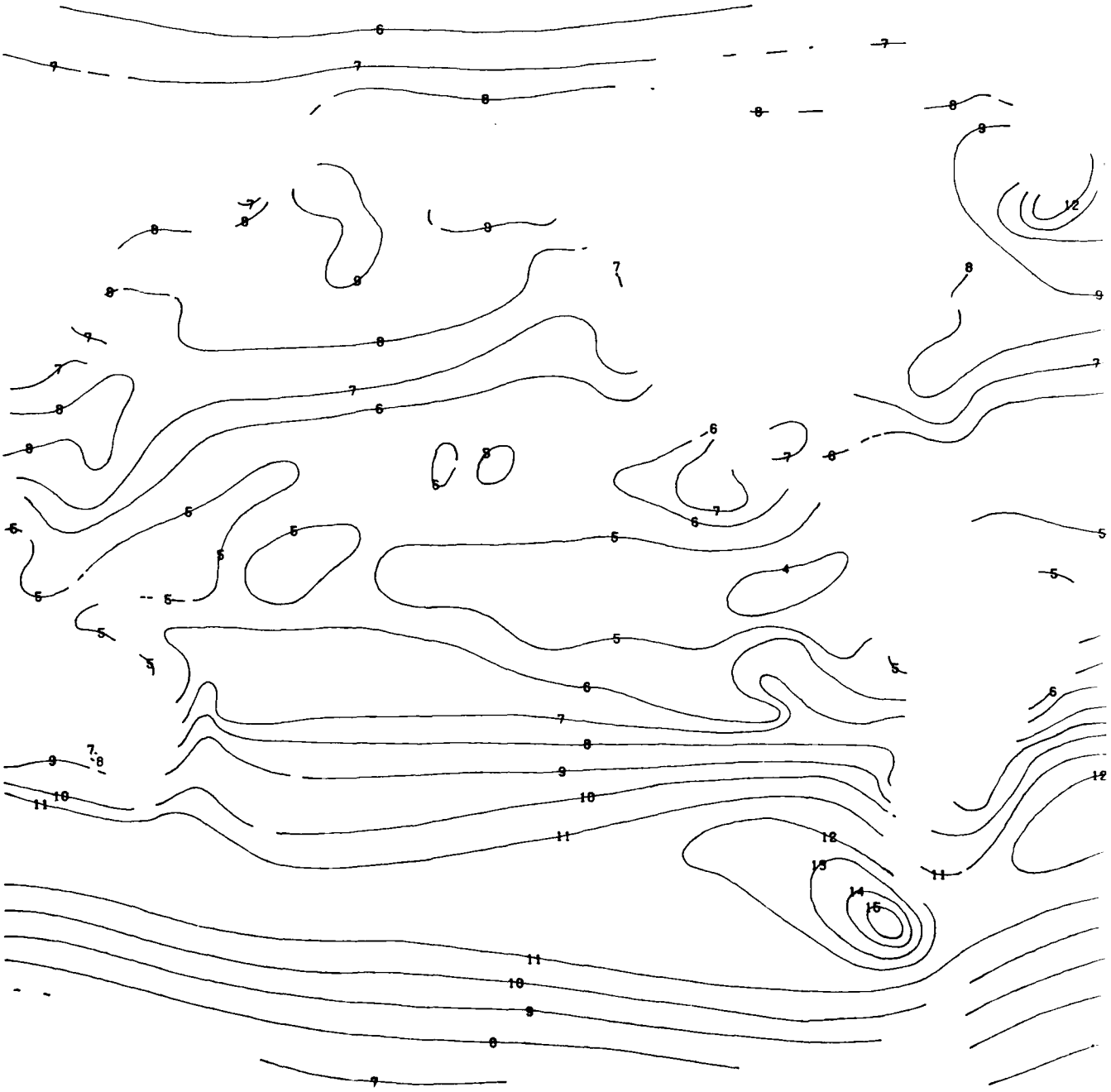
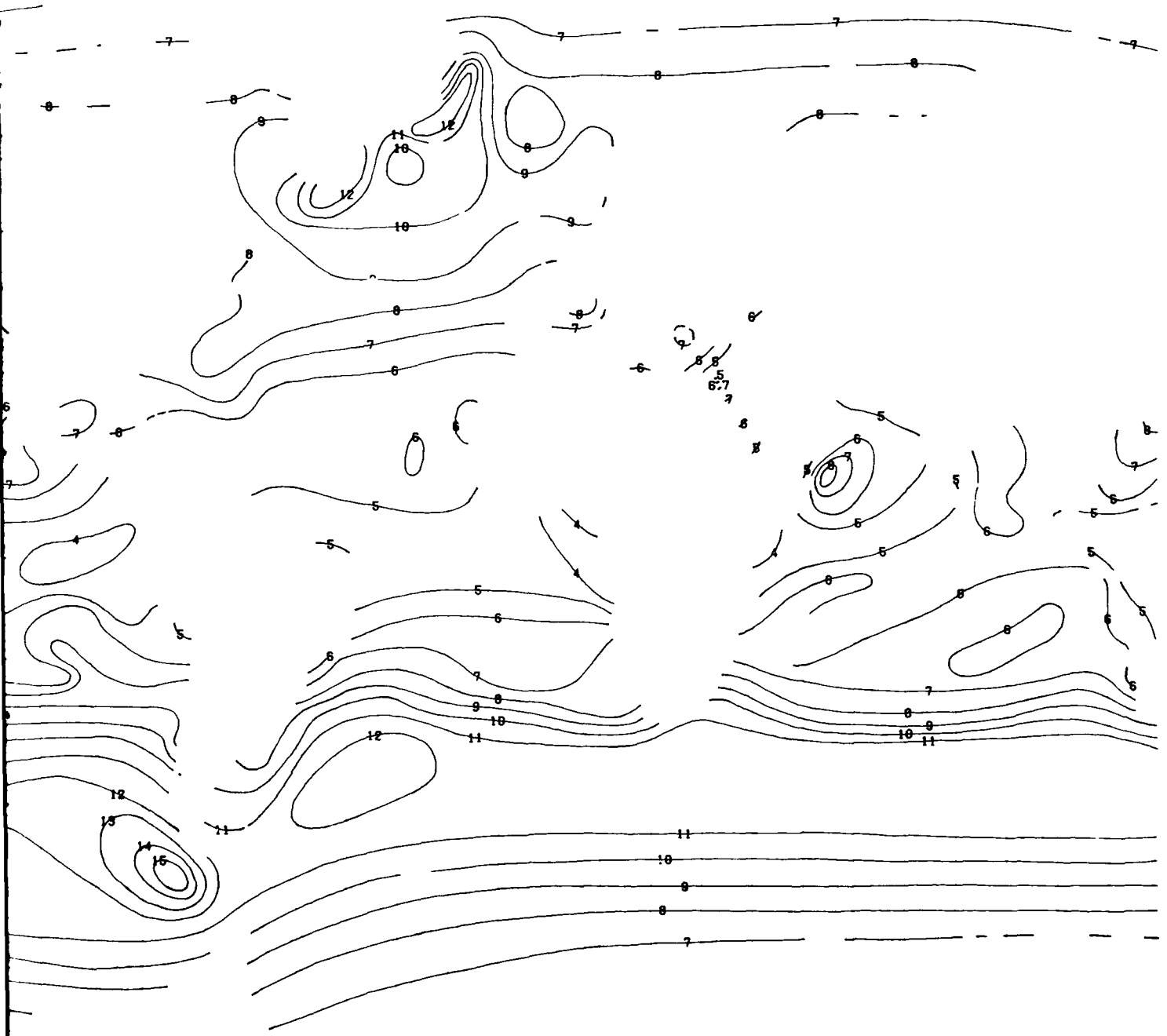


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS





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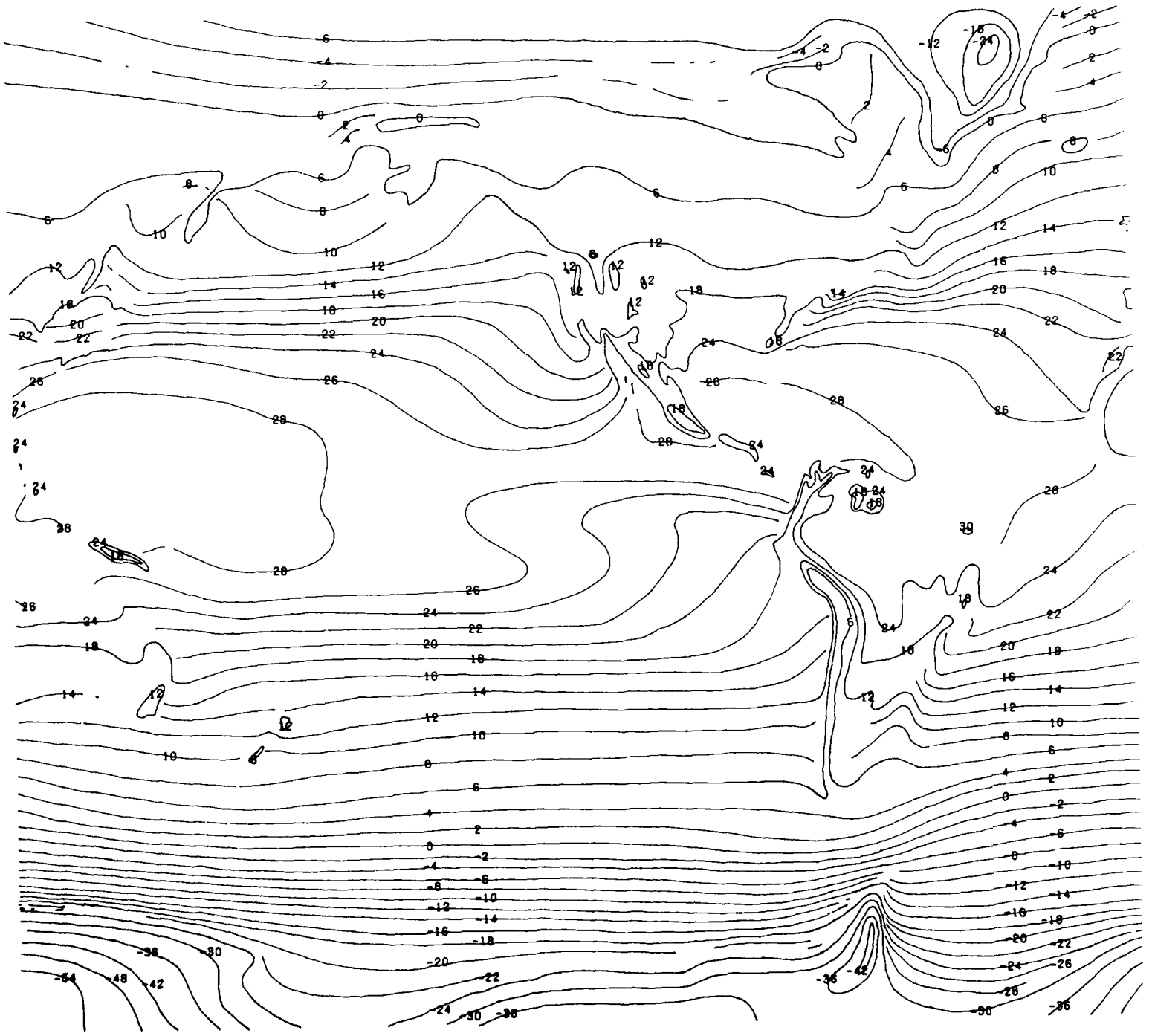
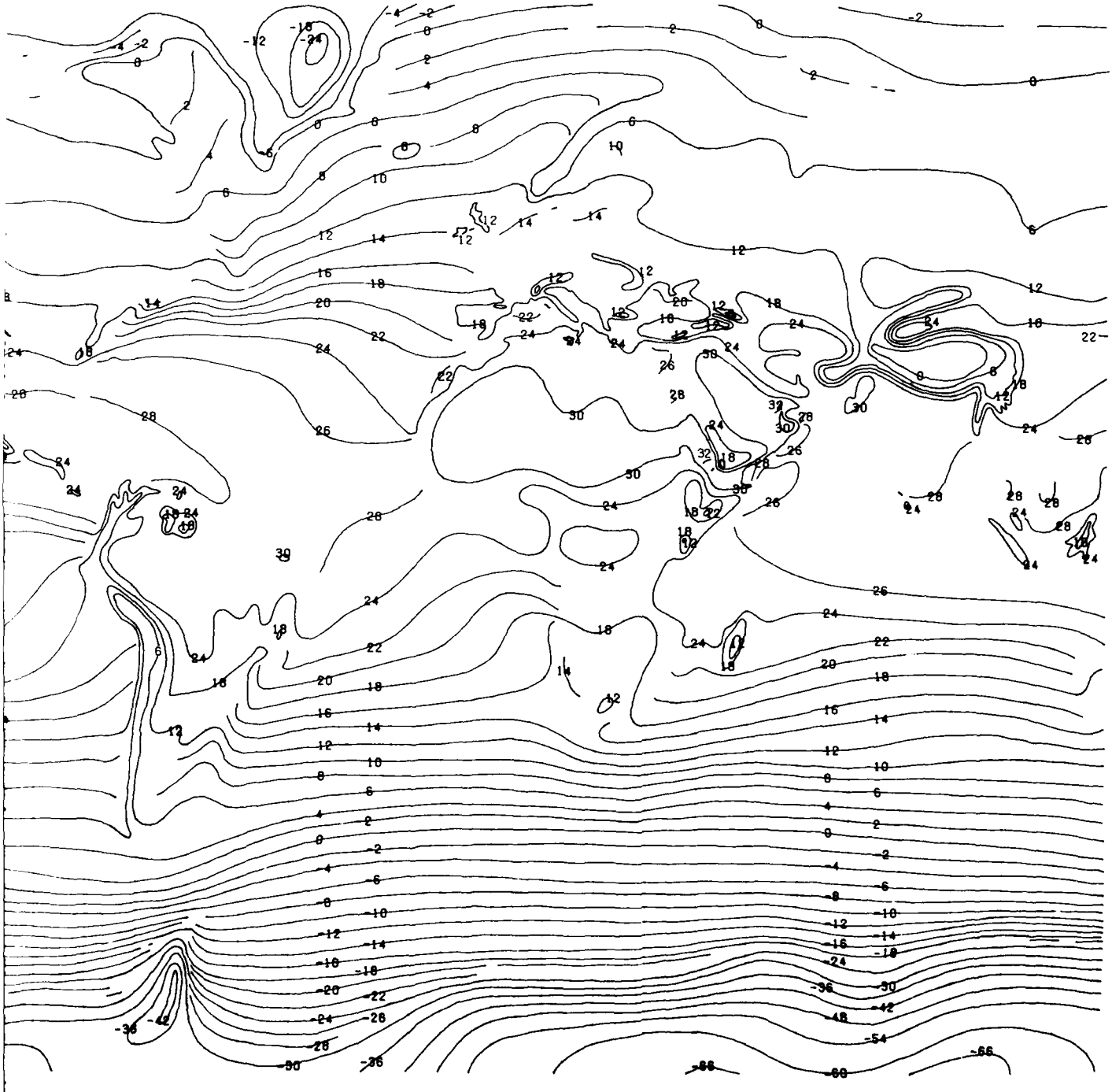
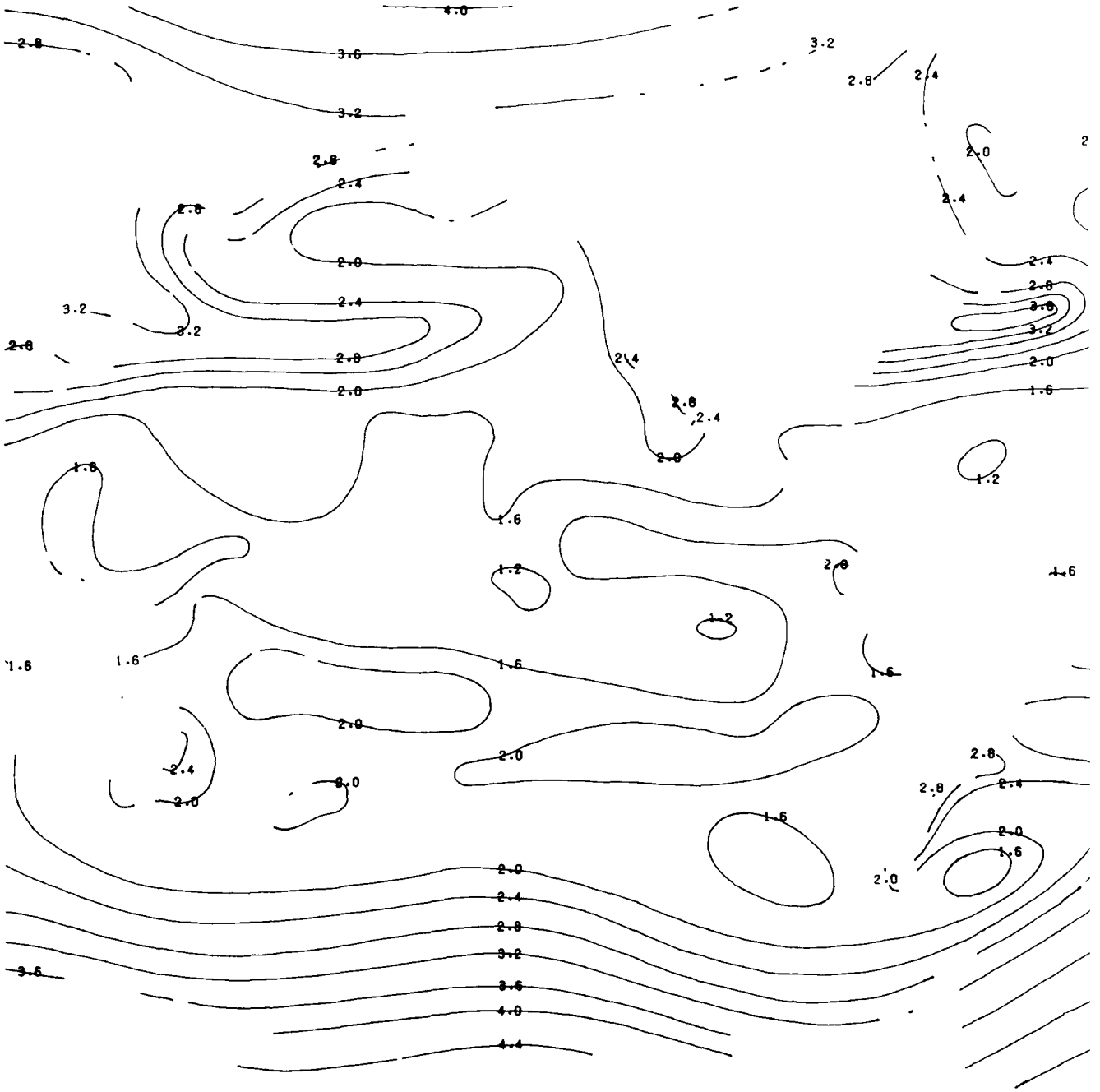


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



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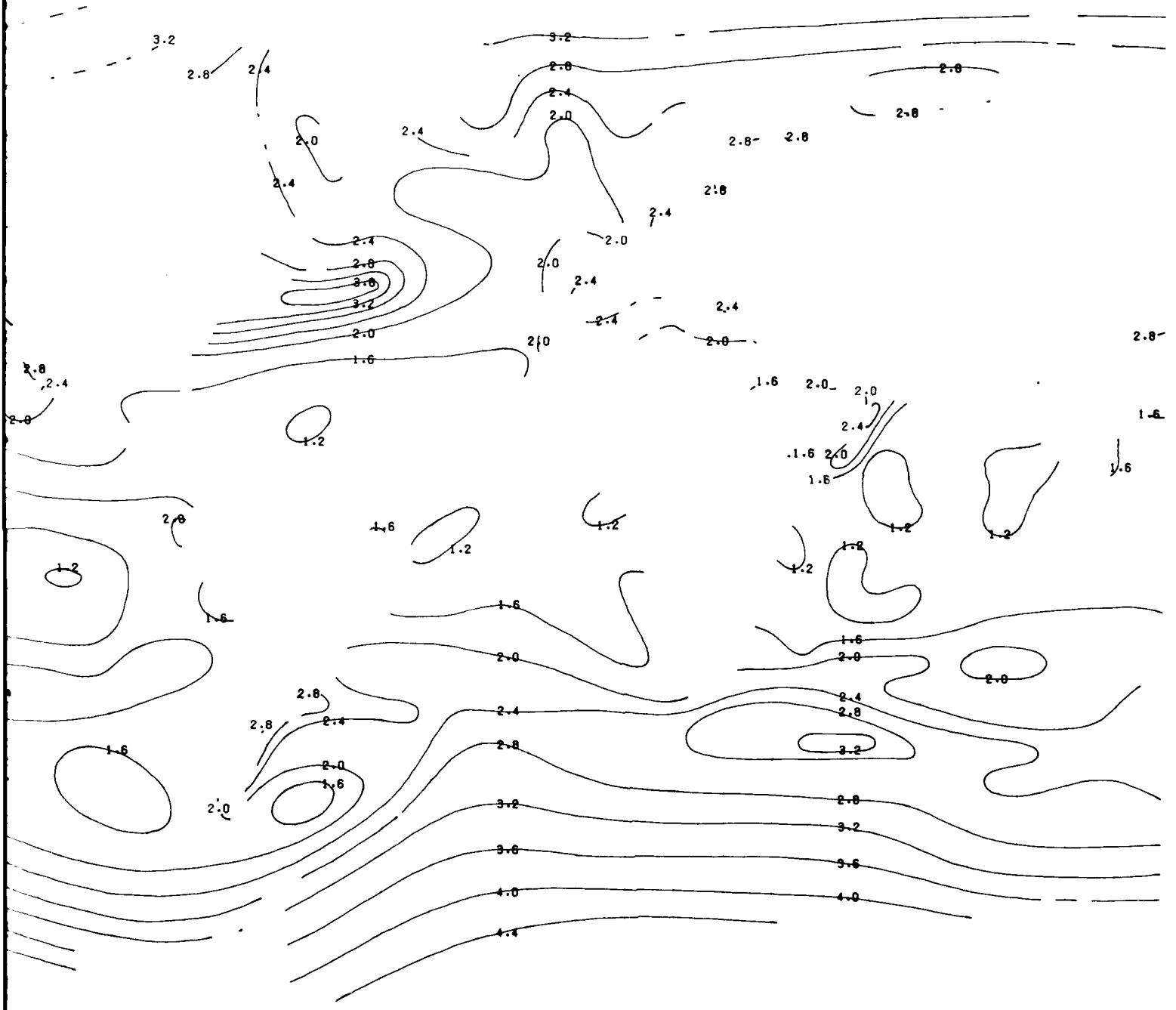

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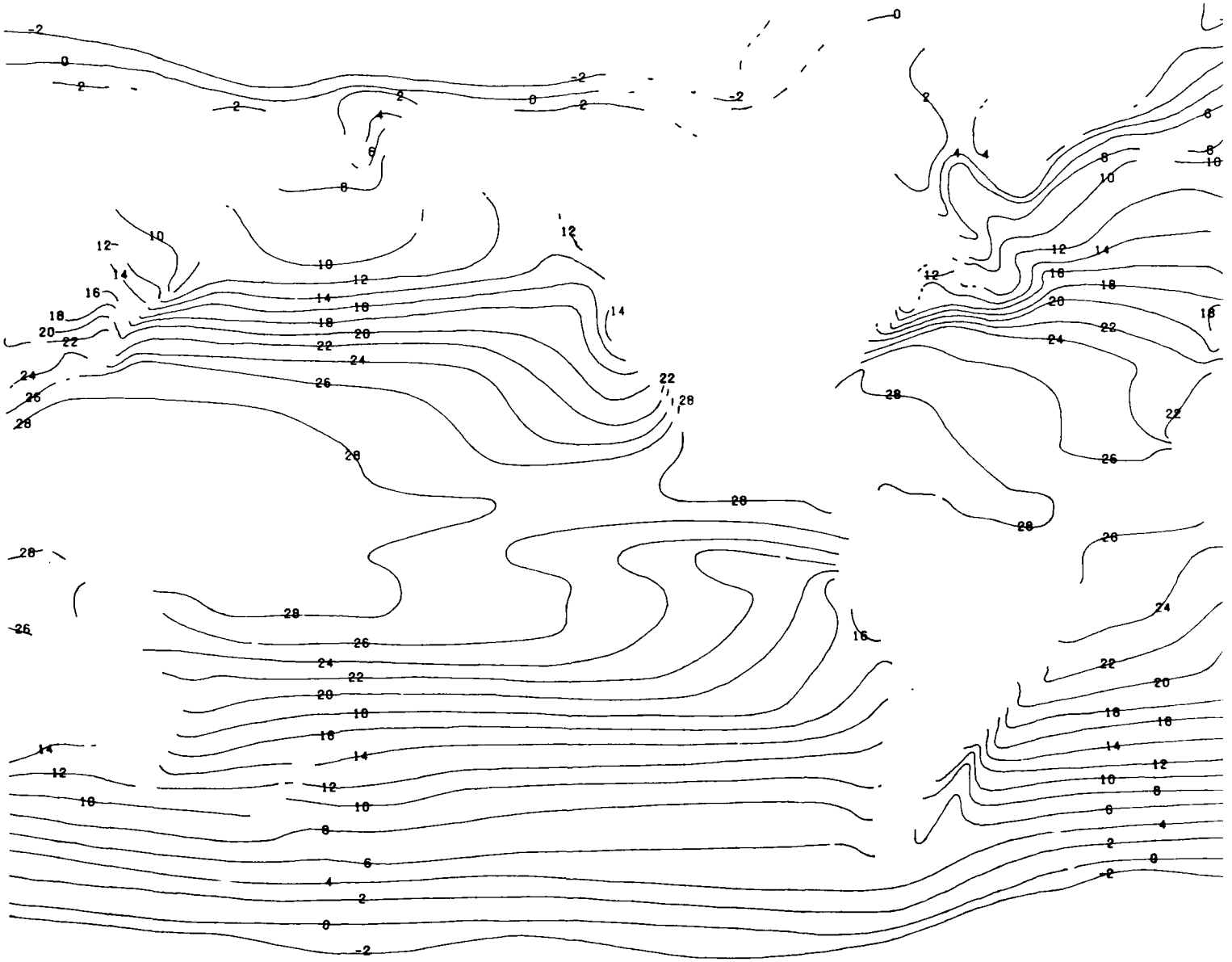
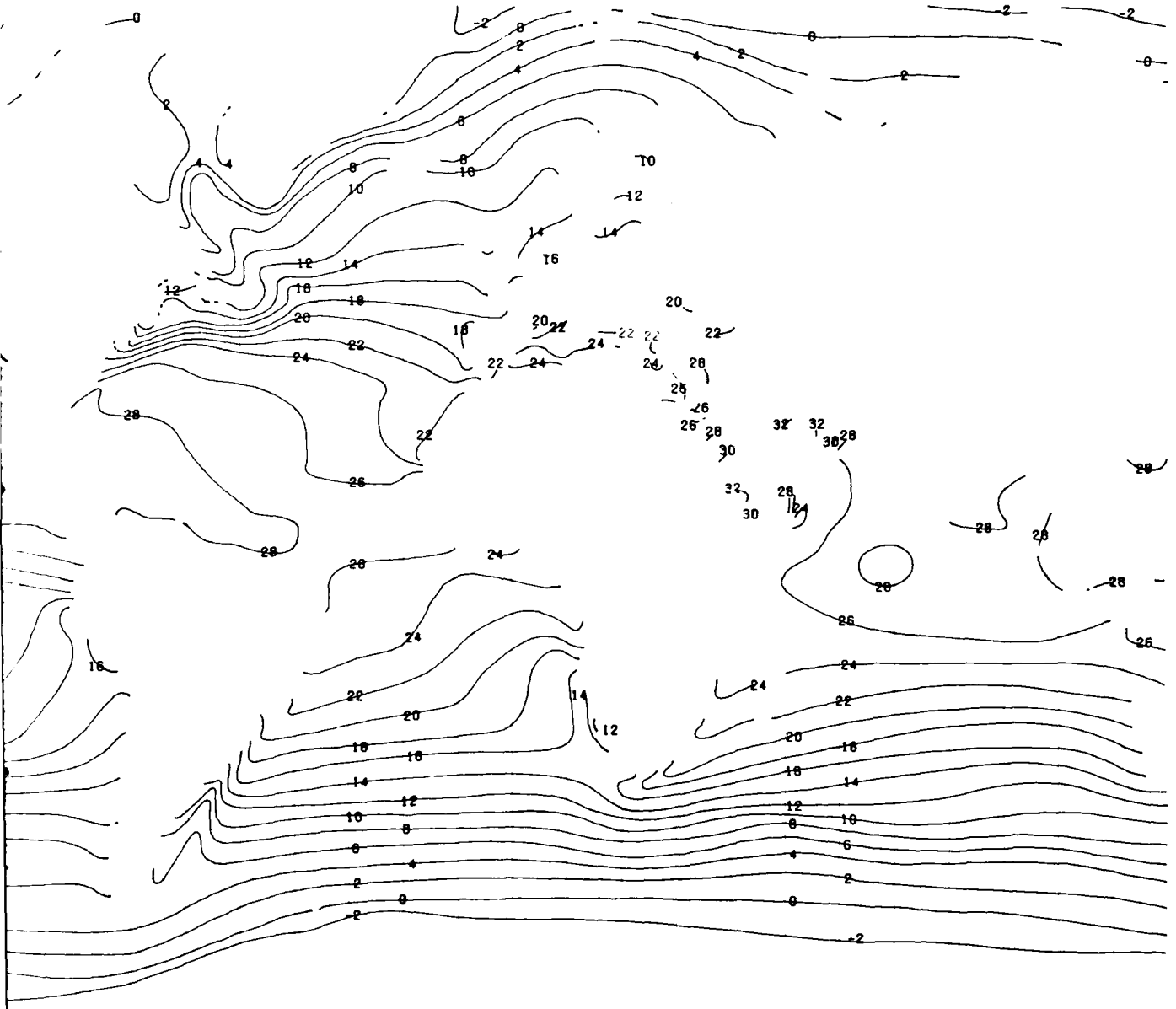
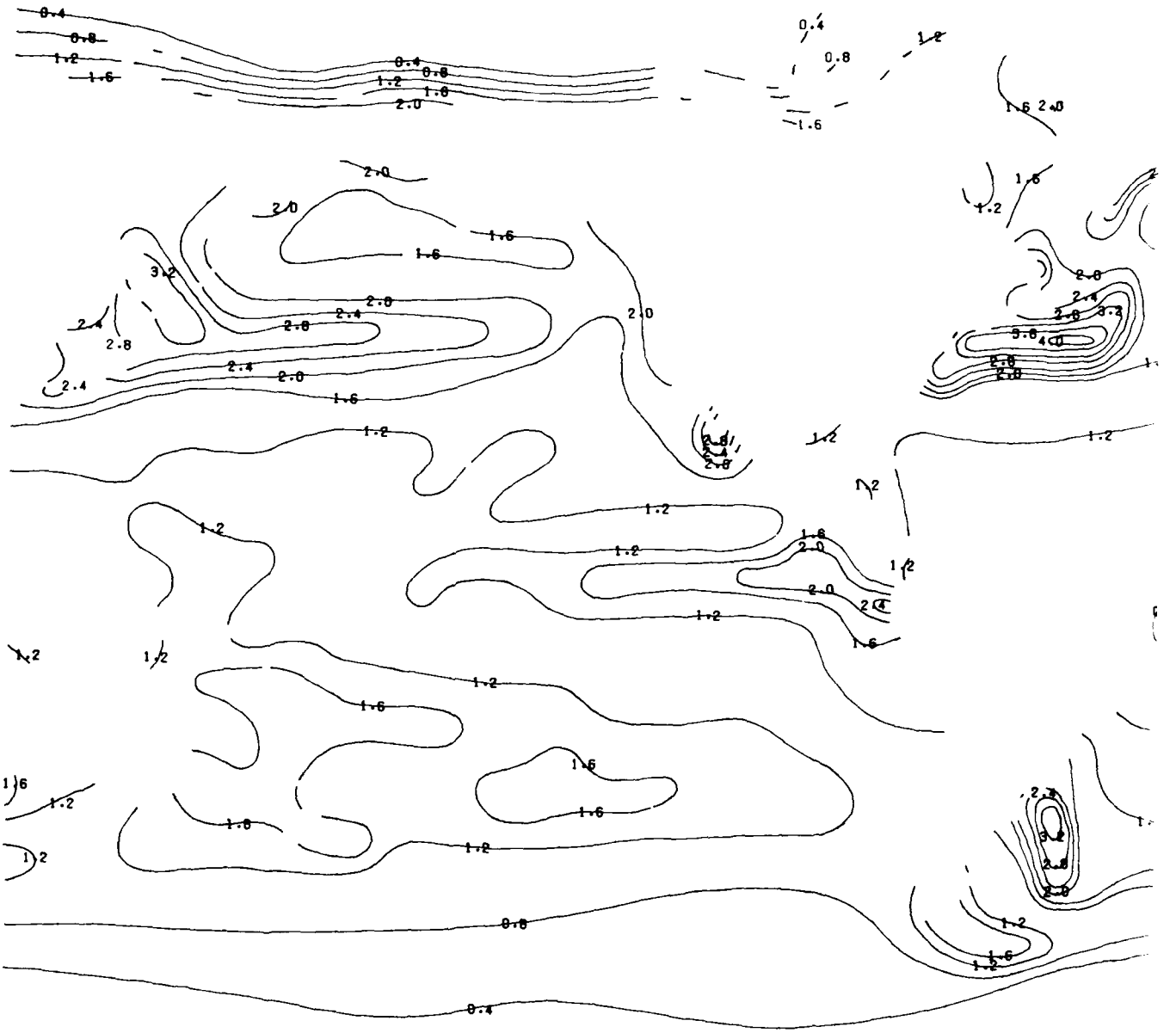


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



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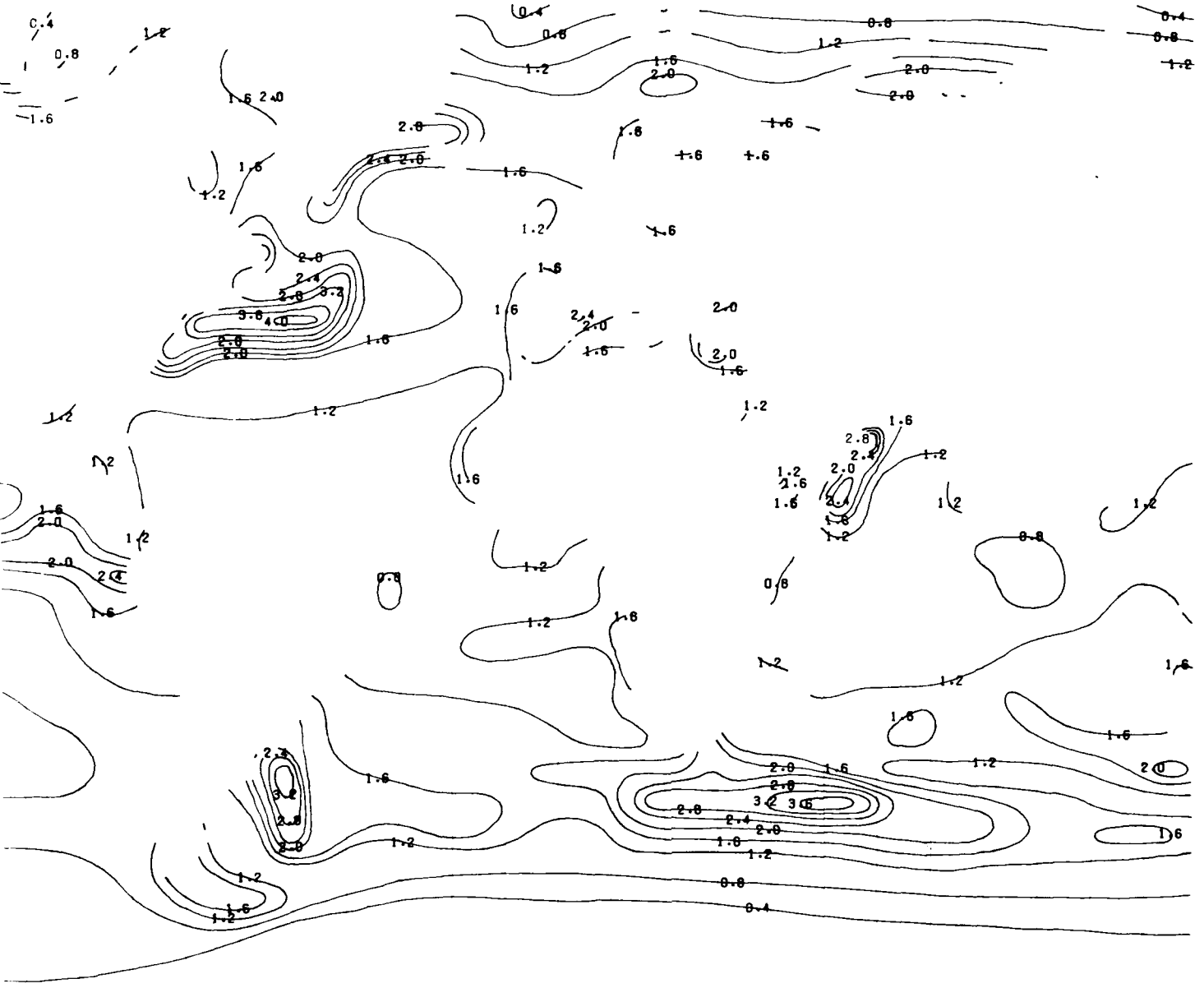

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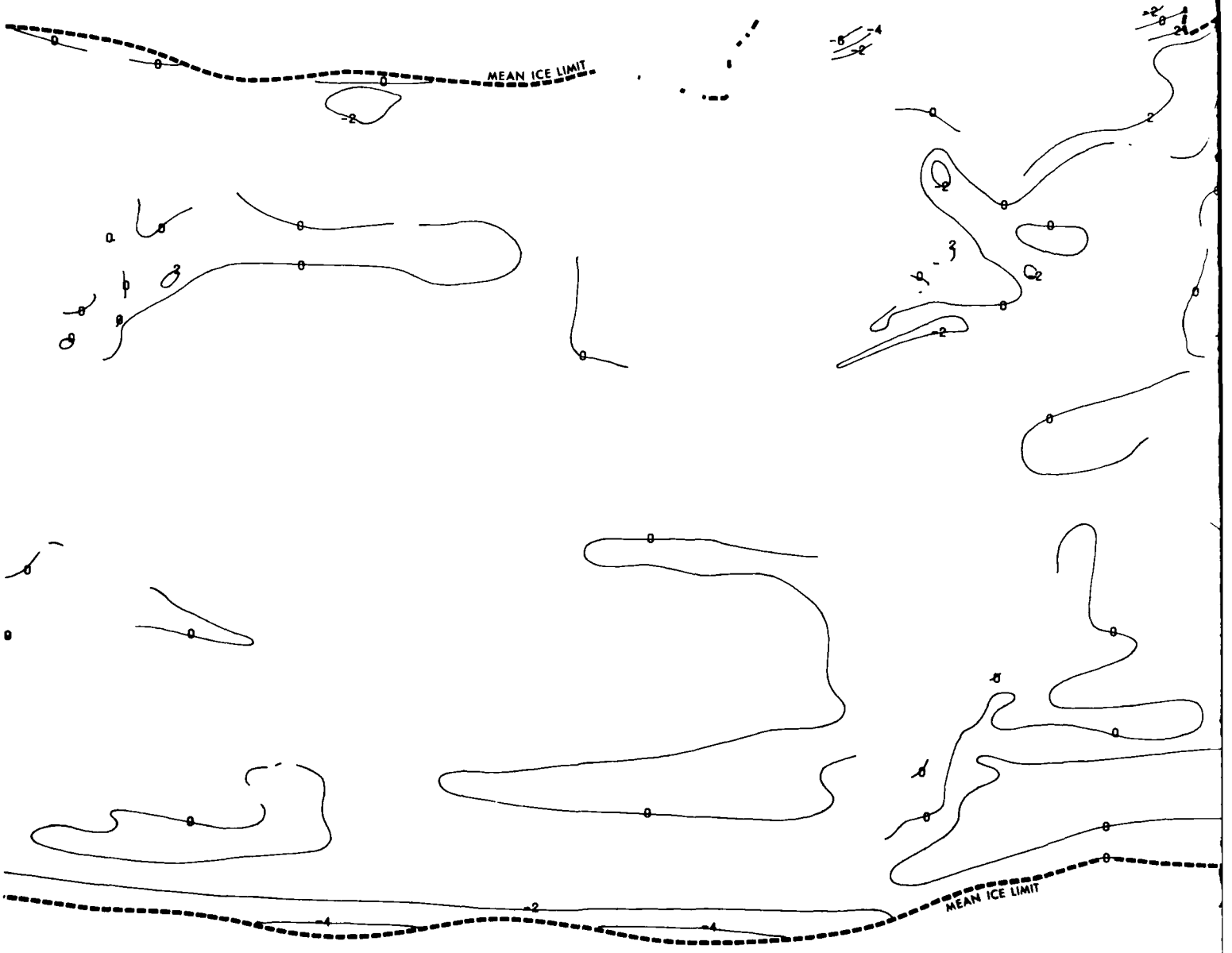
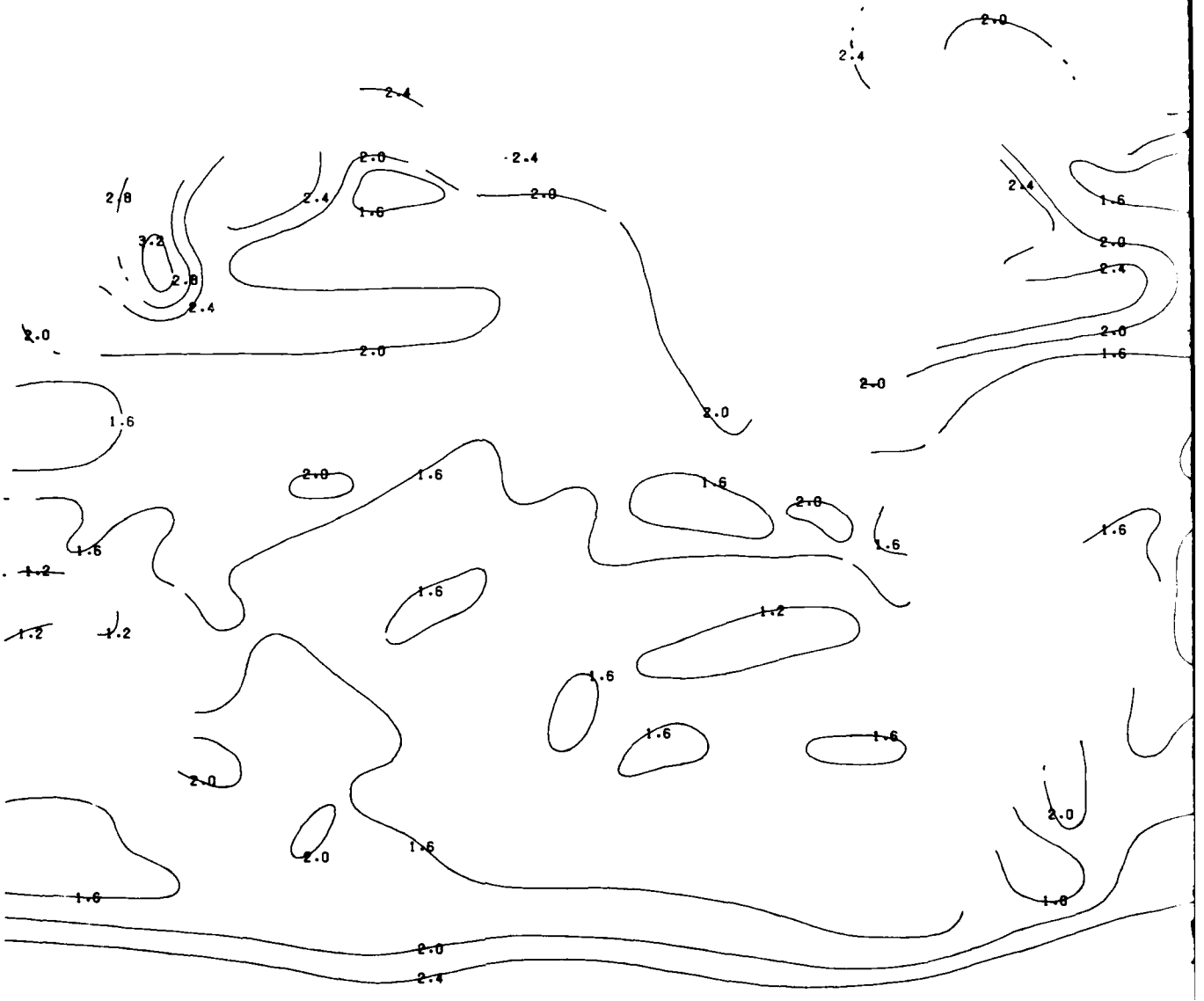
AIR-SEA TE



AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATION



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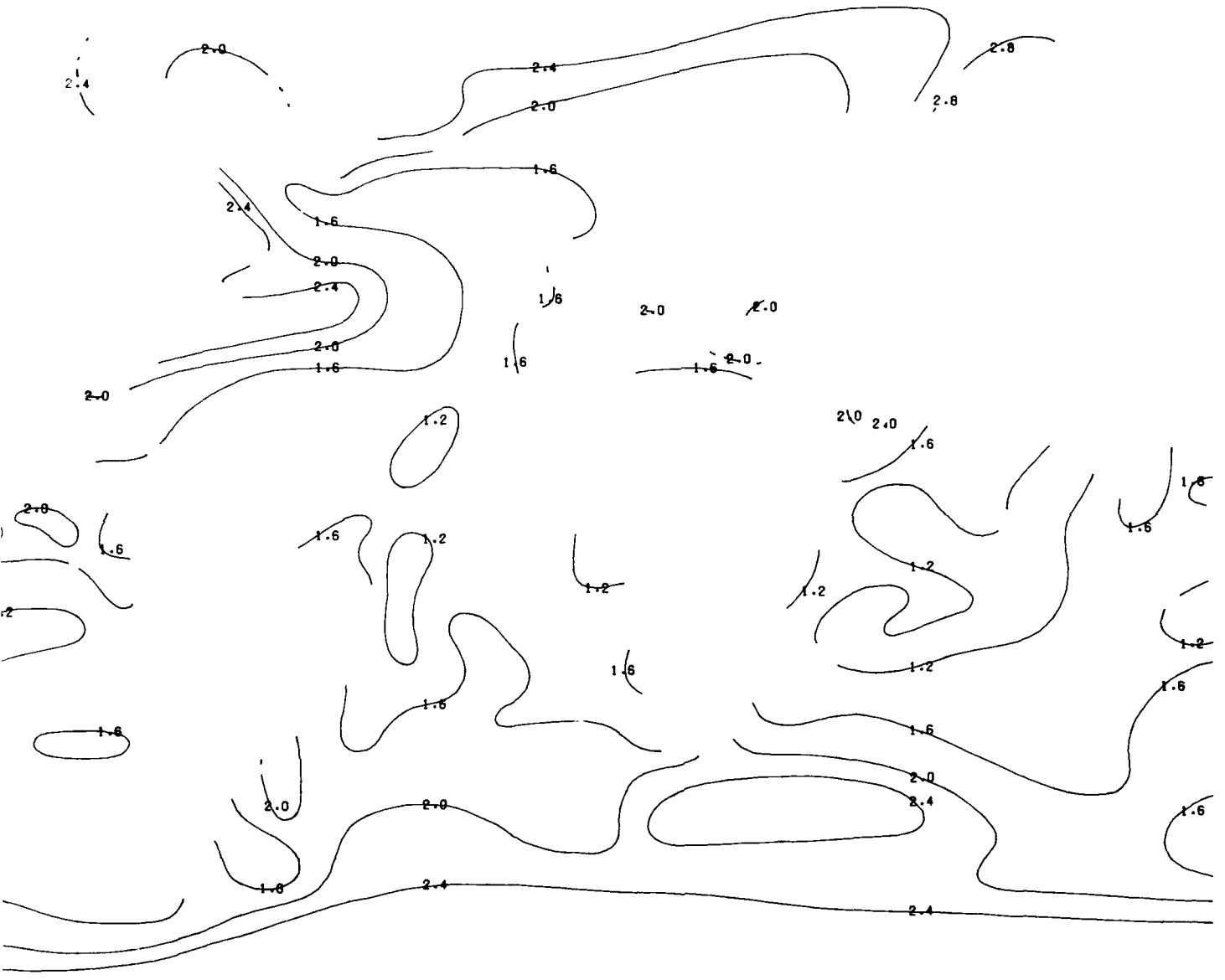

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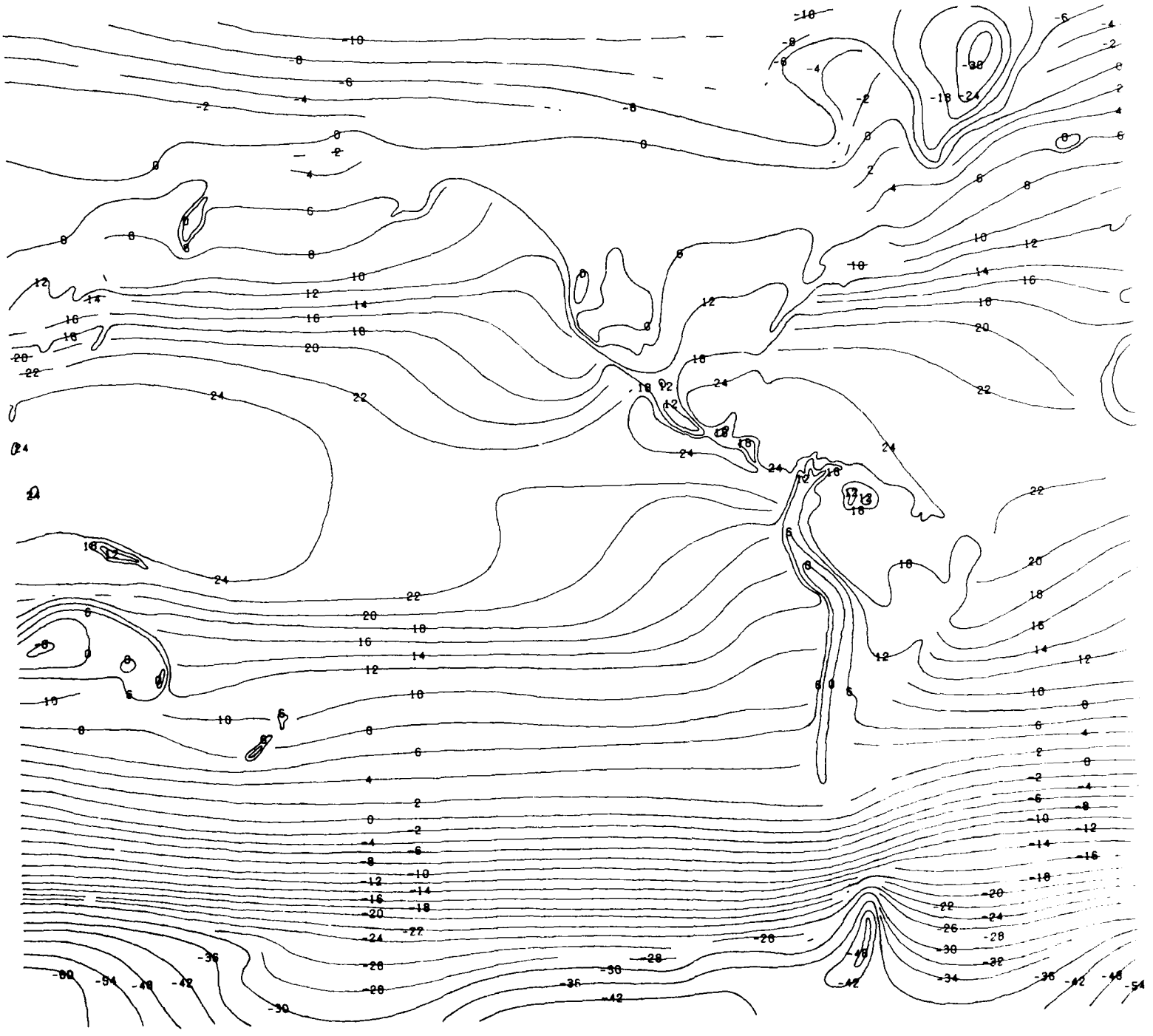
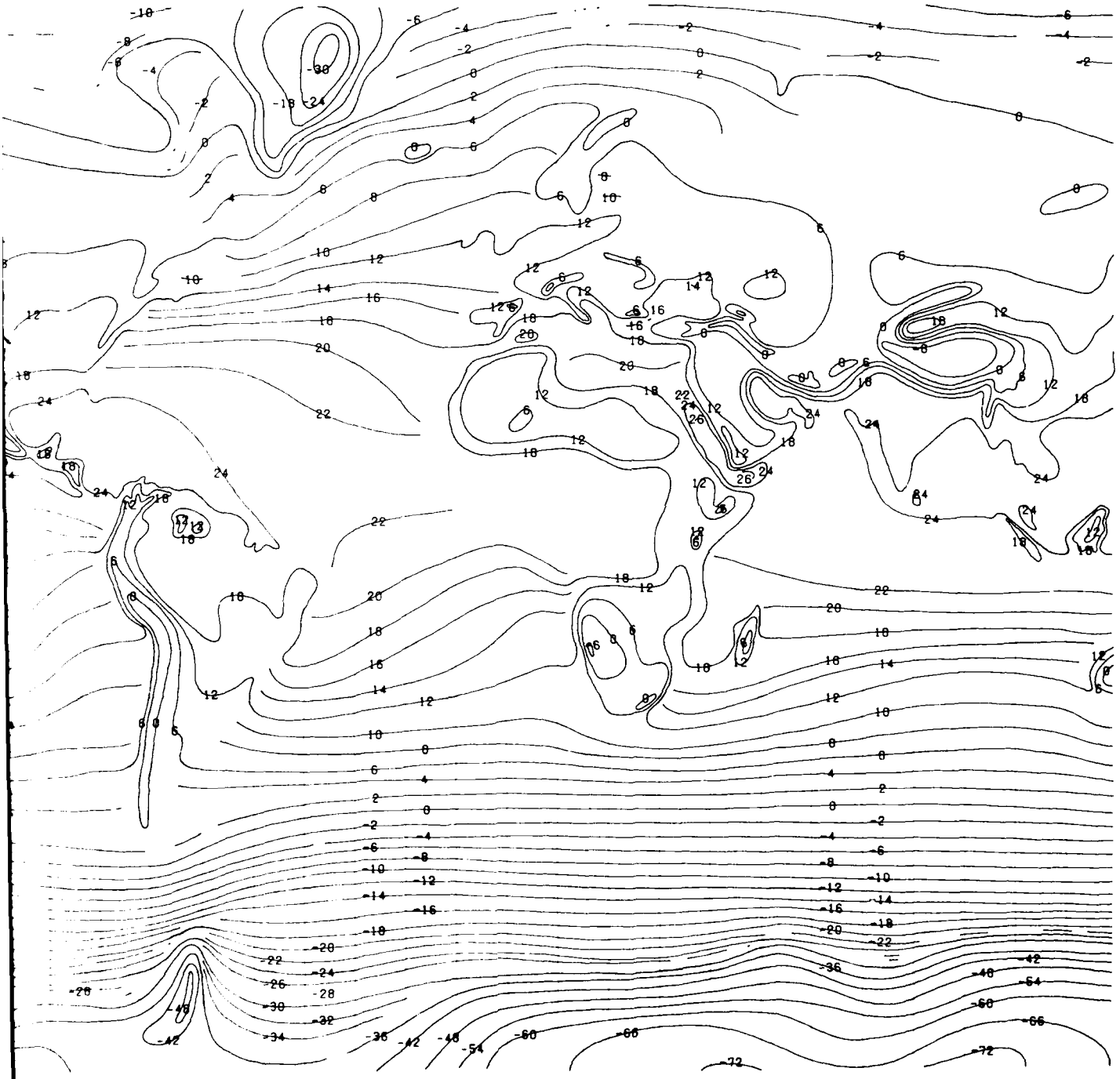
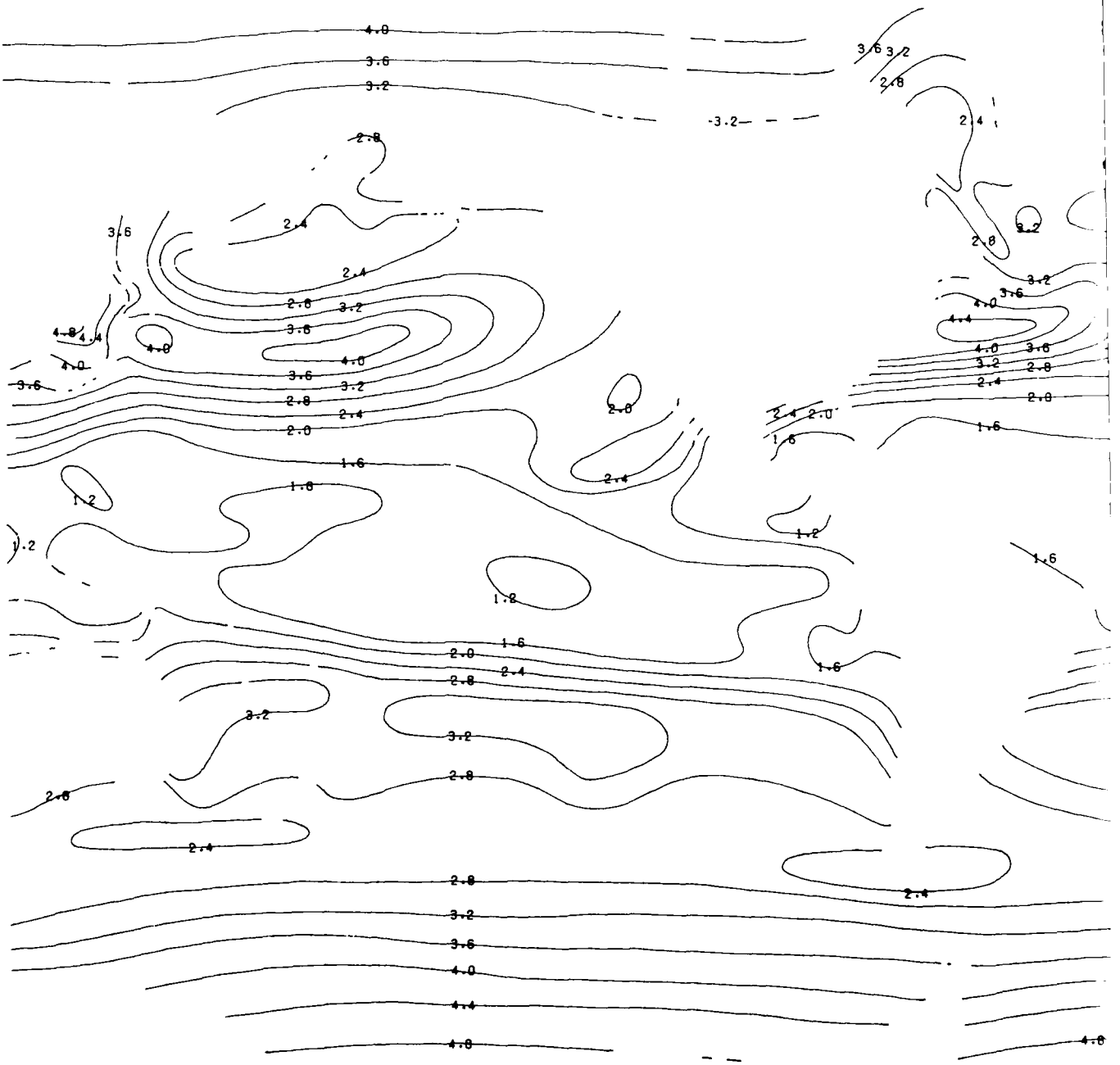


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



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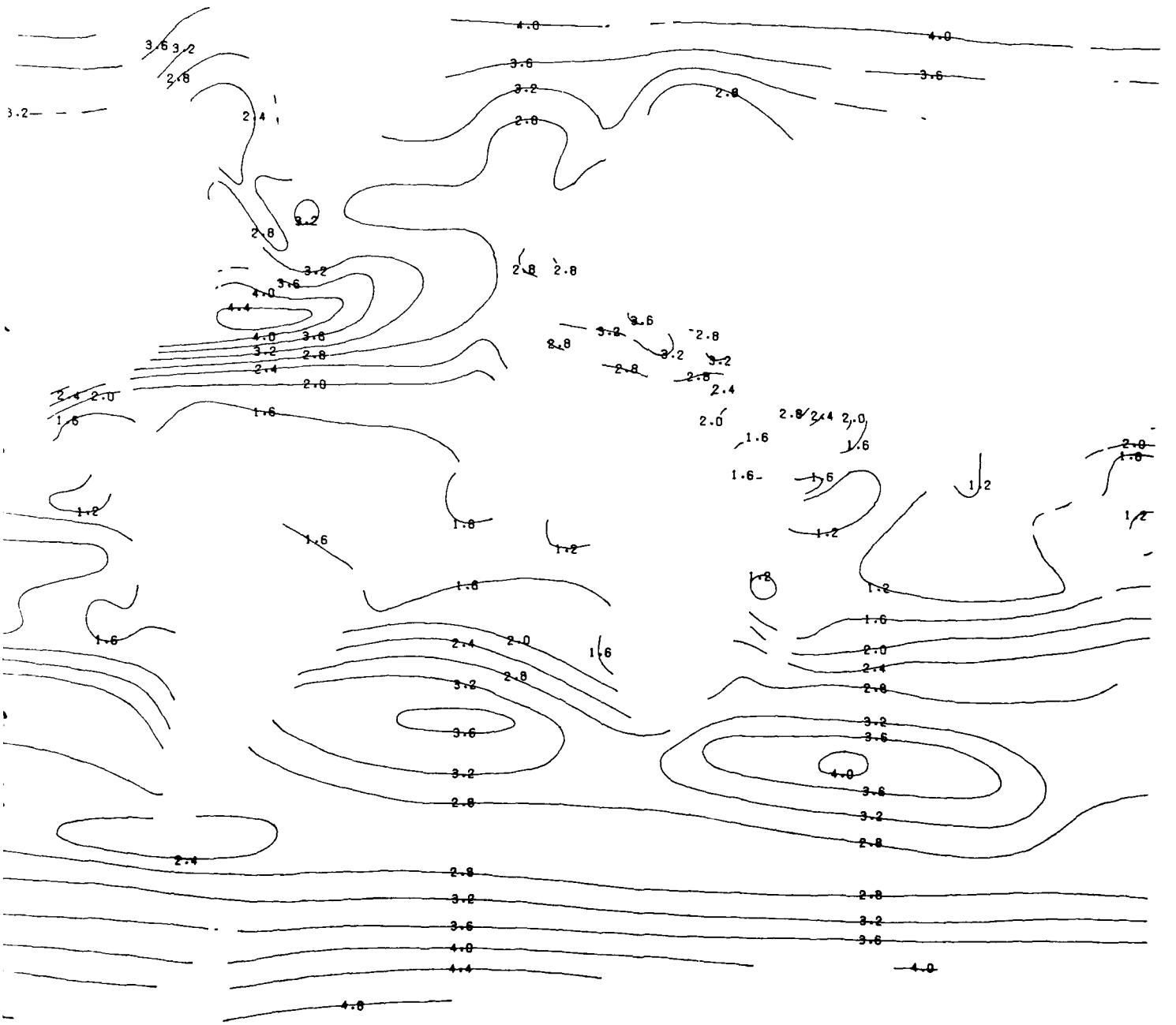

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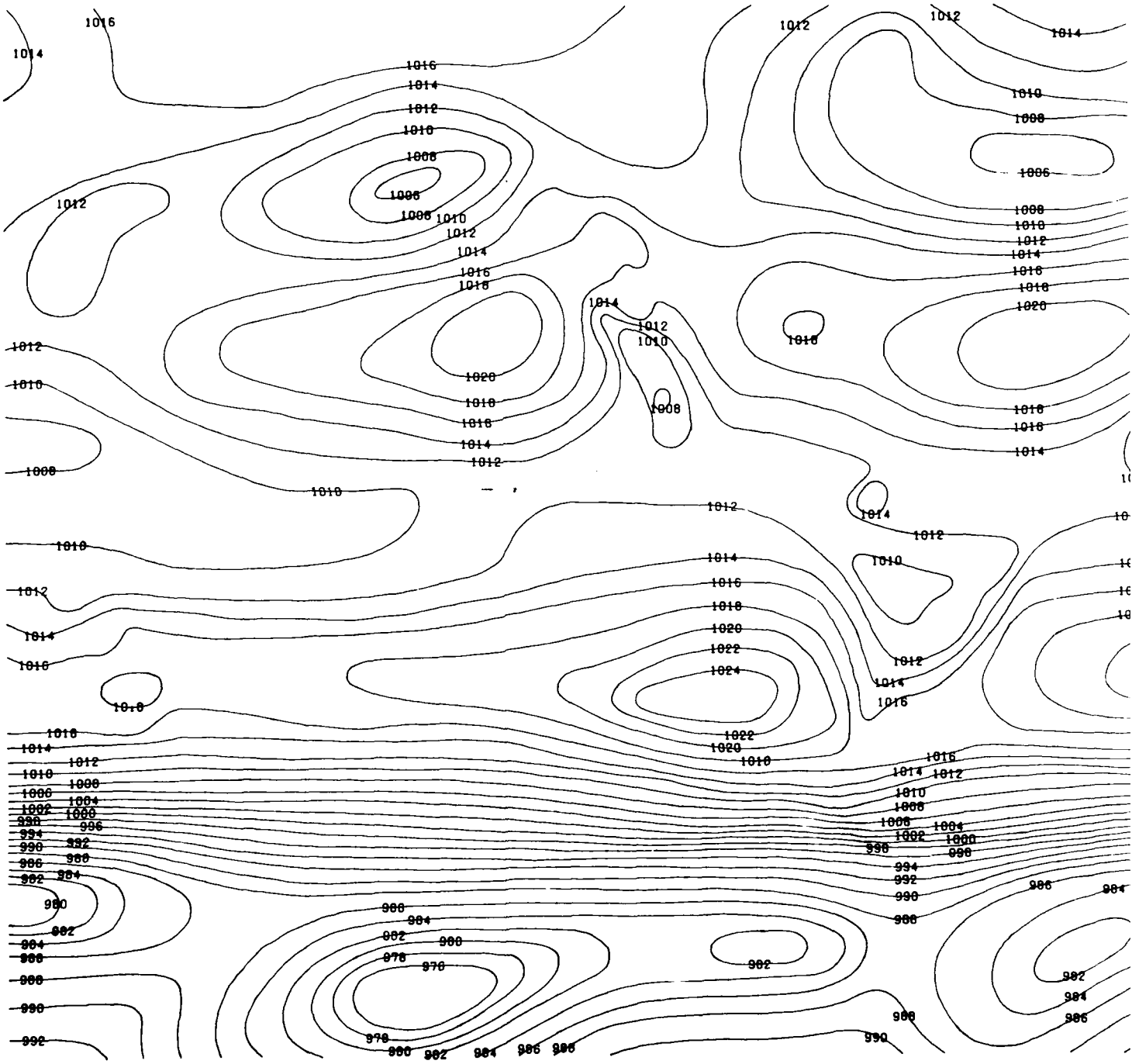
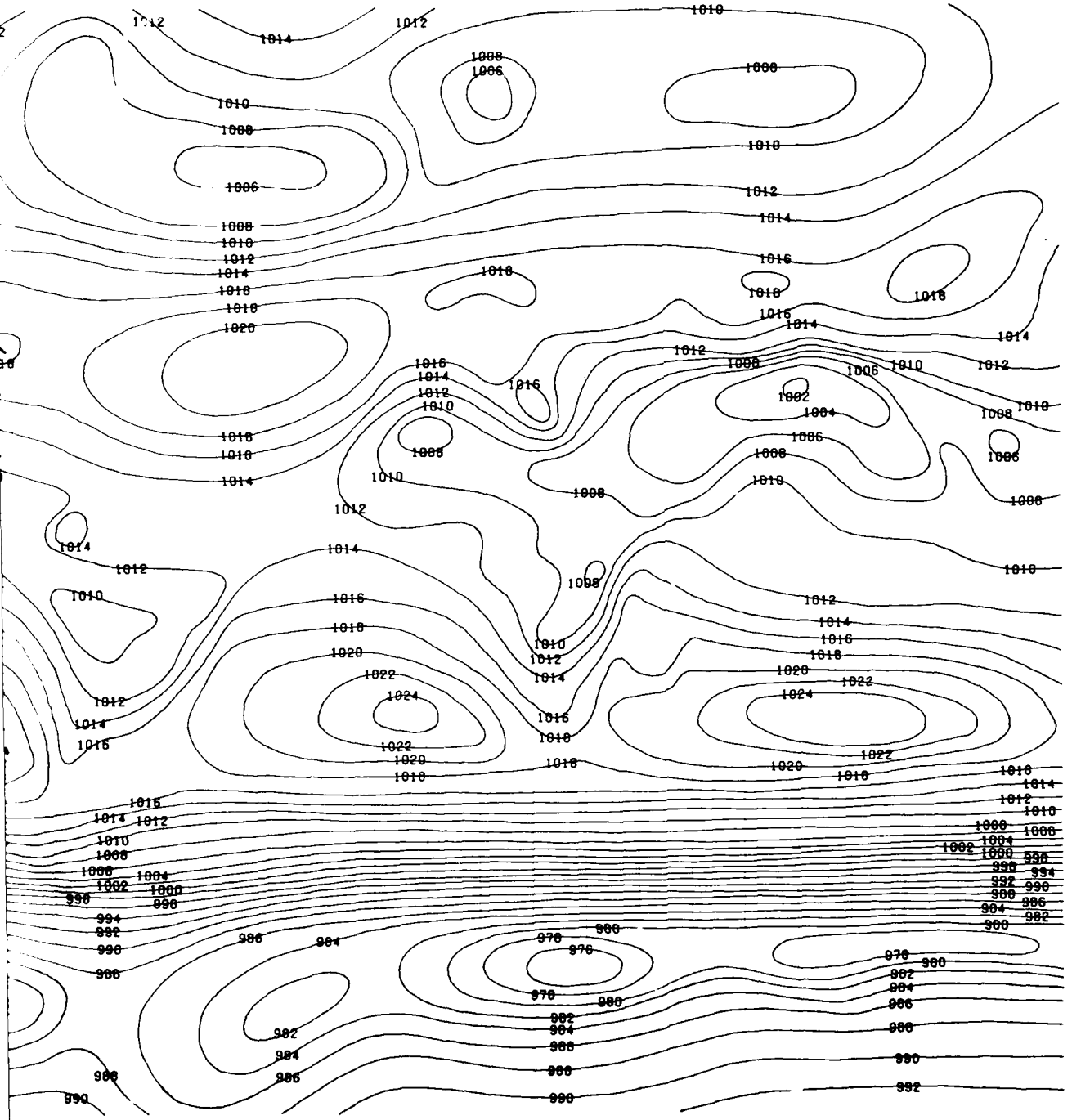
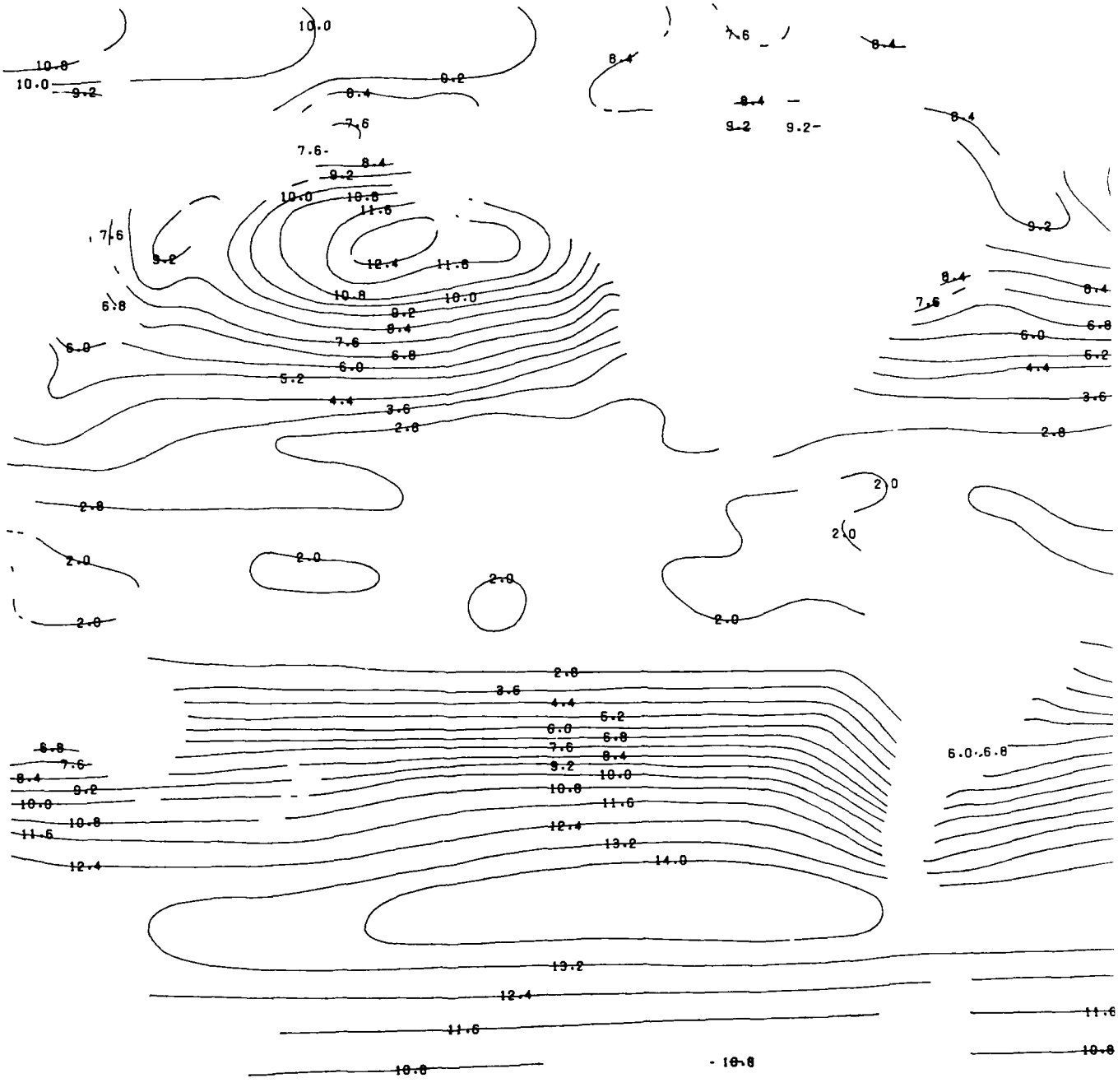


SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



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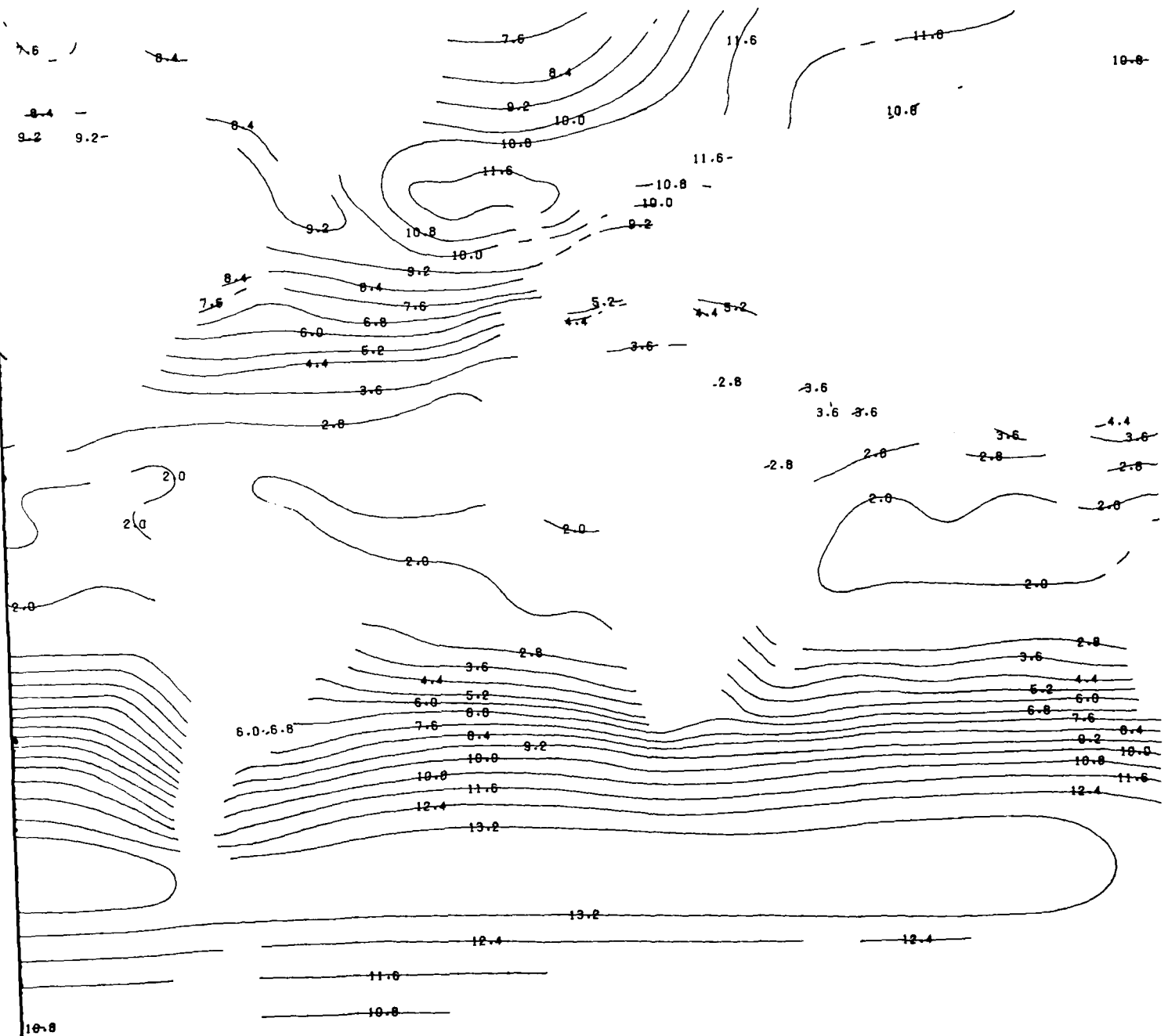

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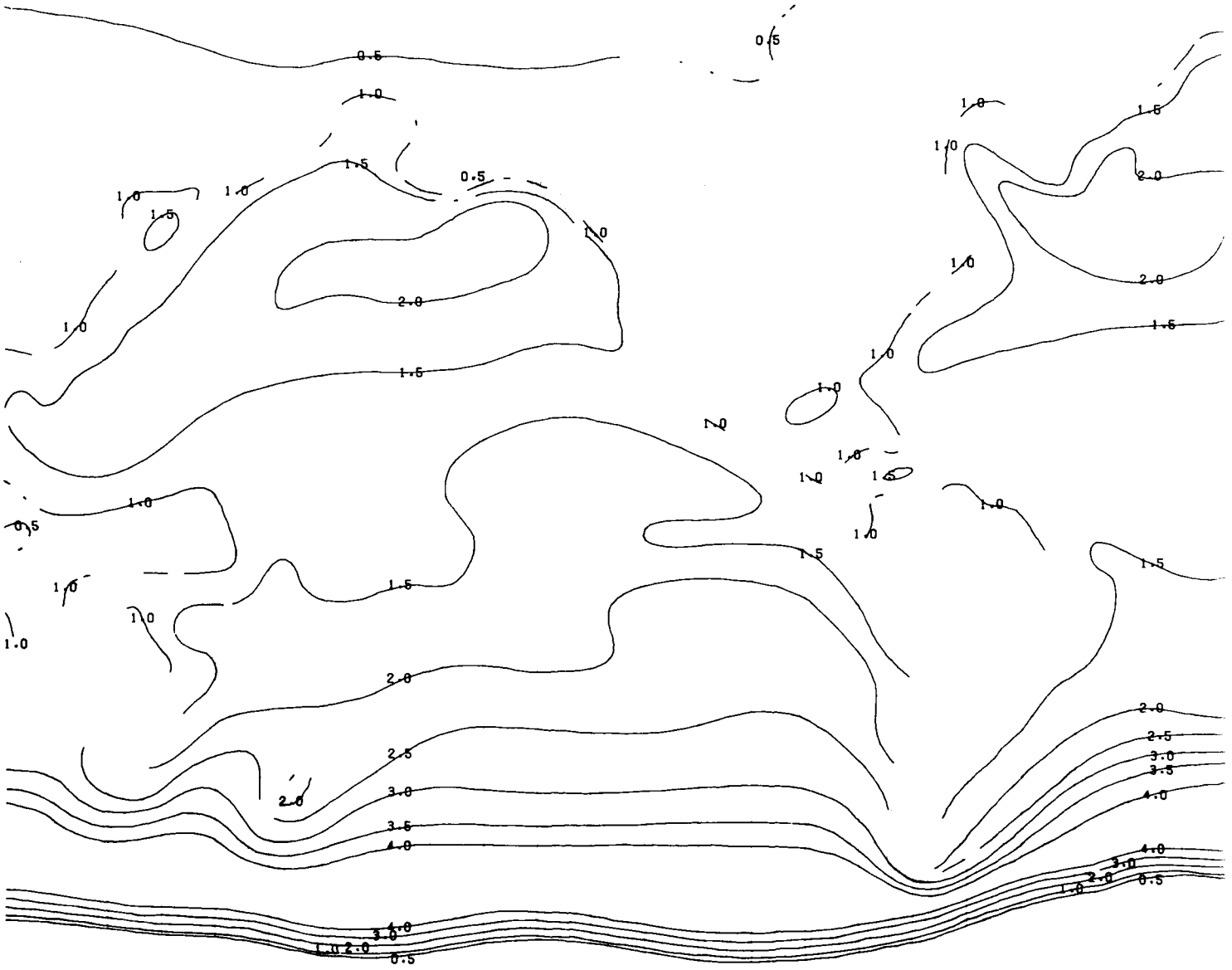
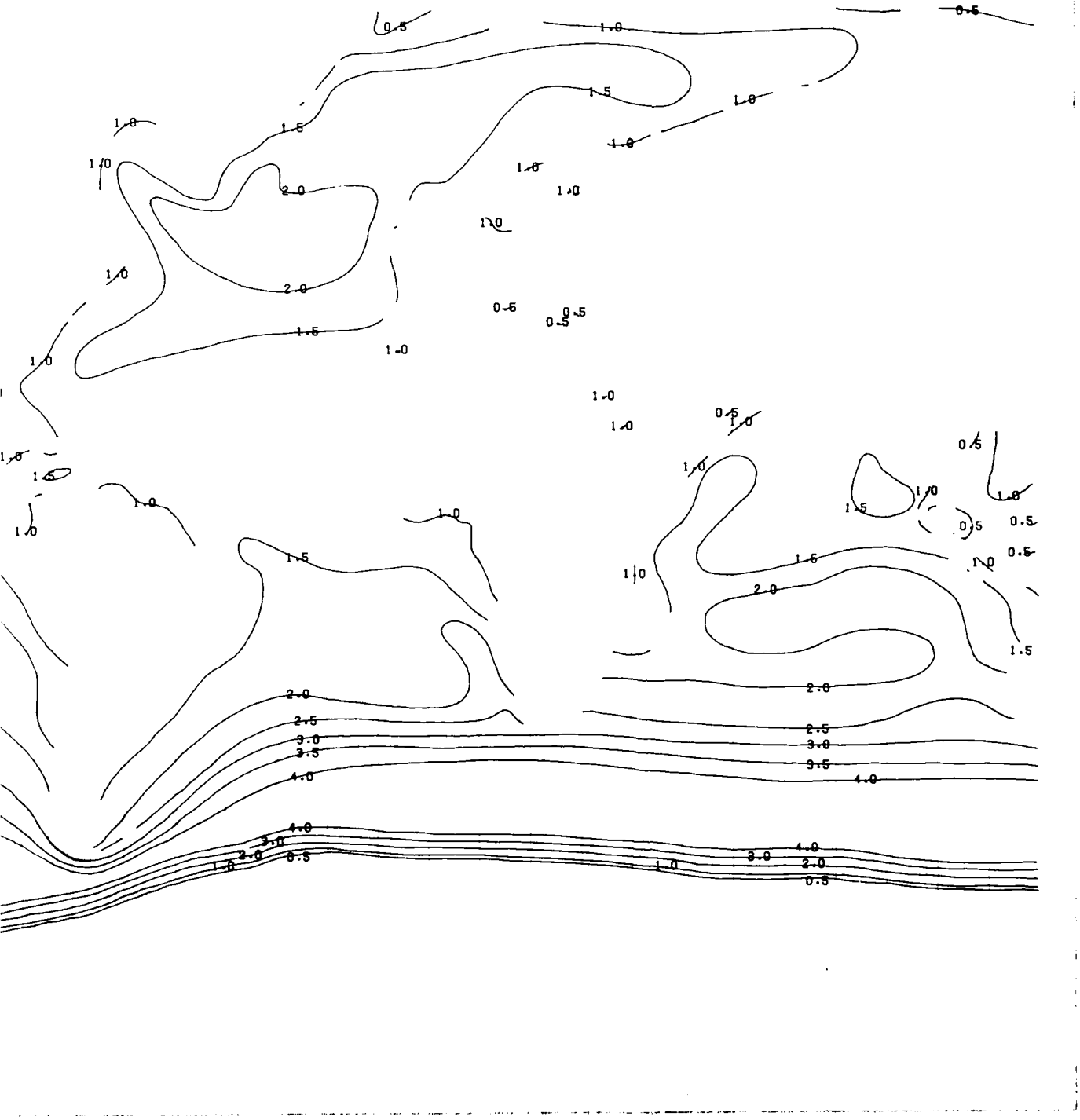
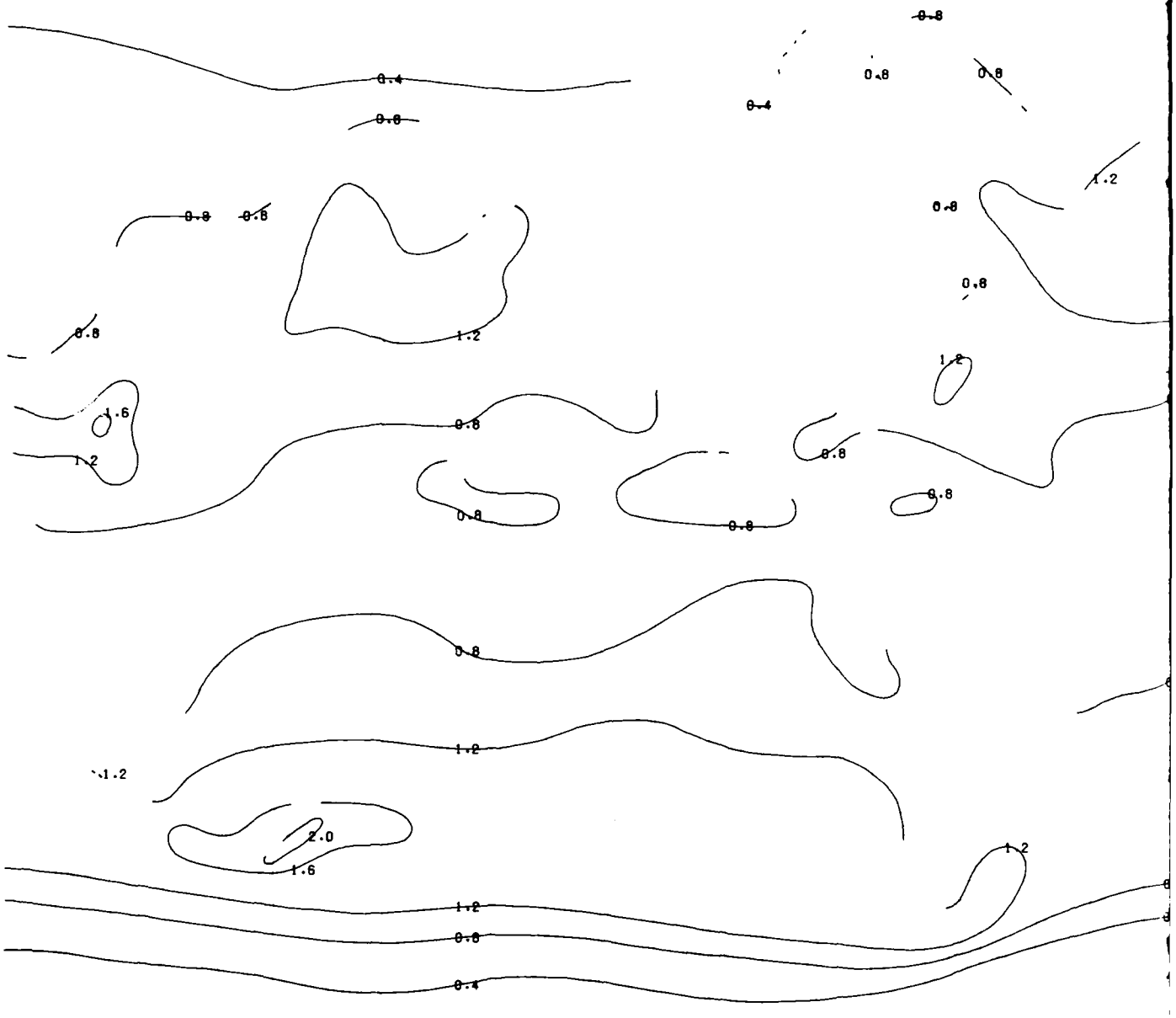


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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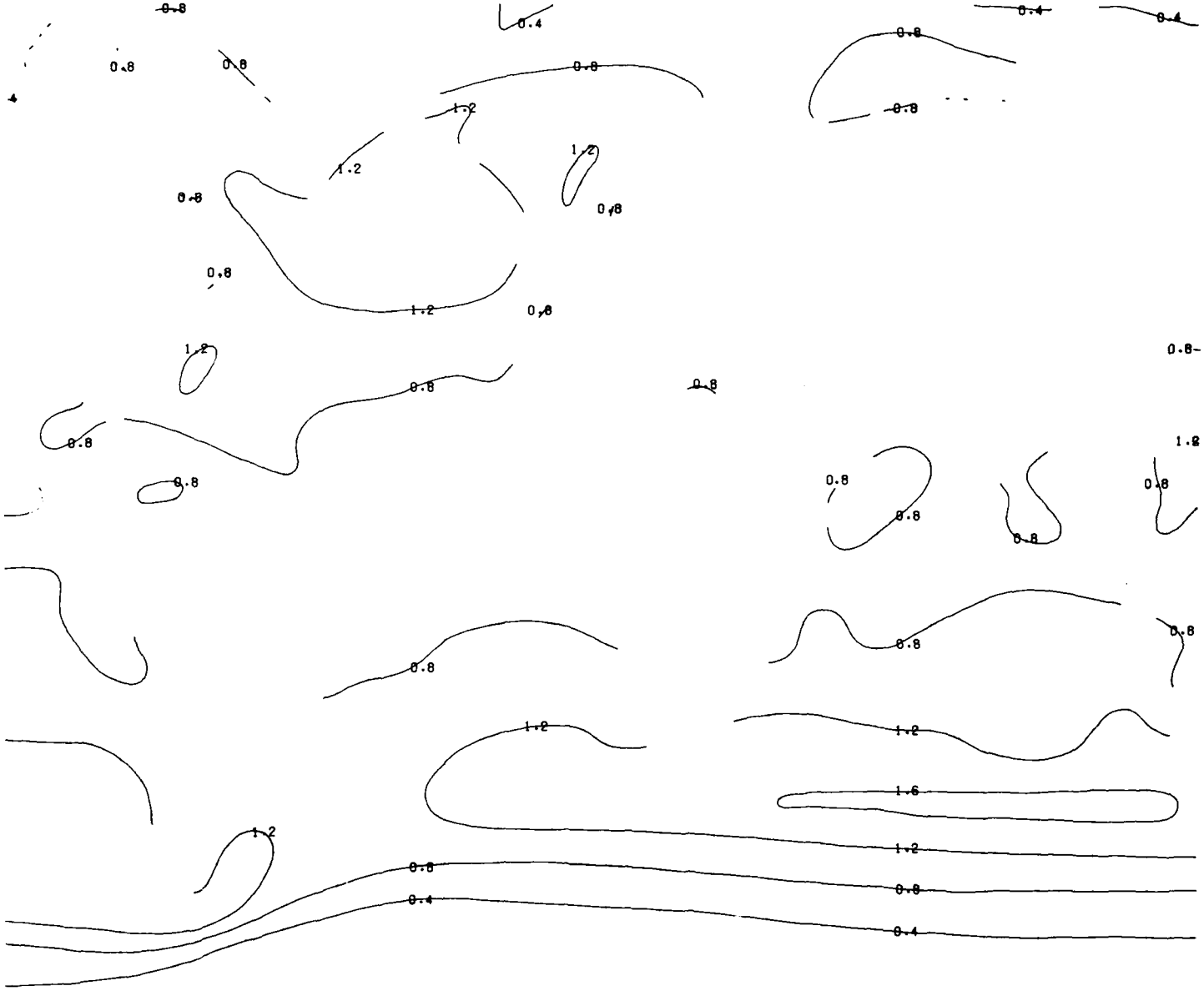

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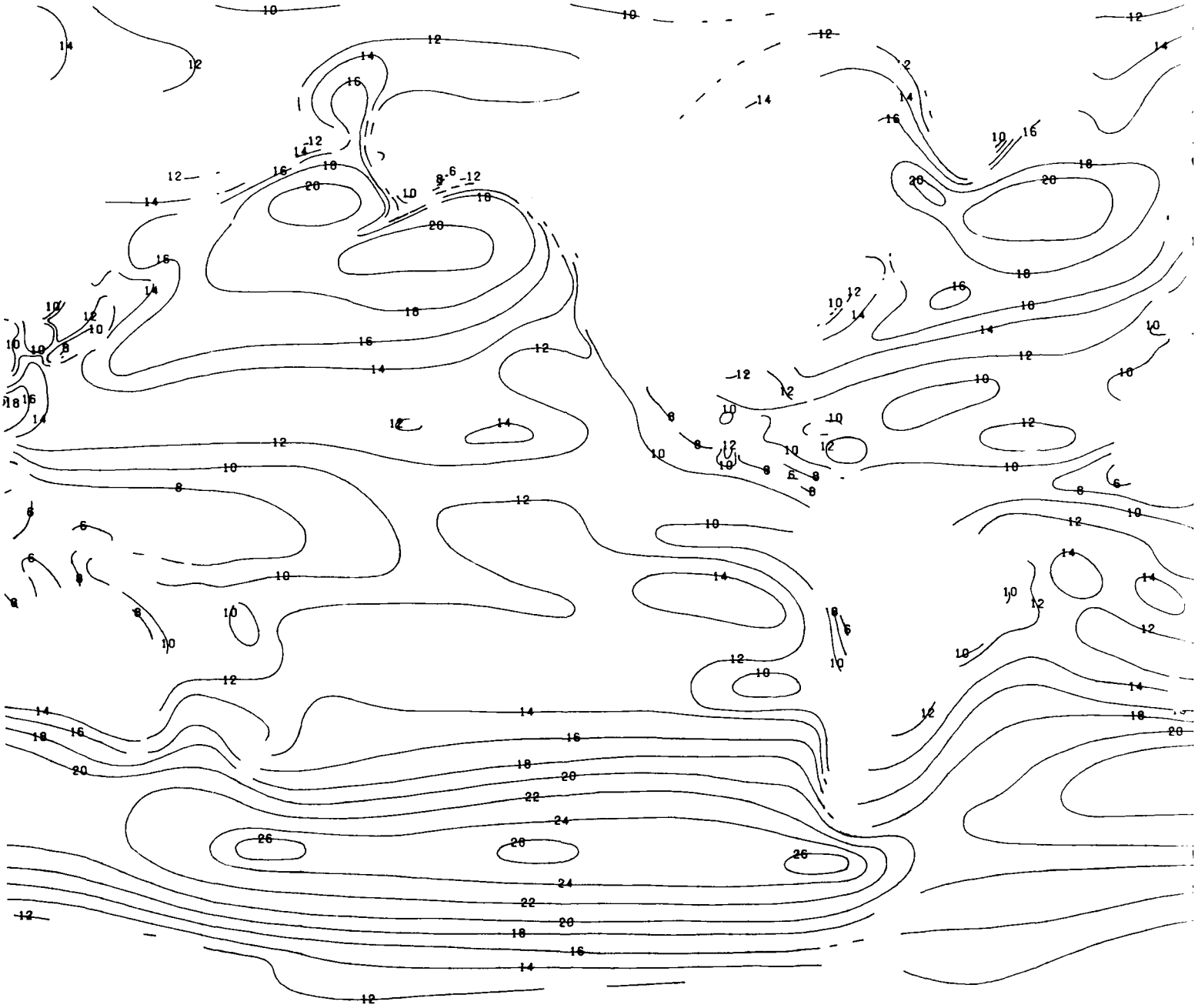
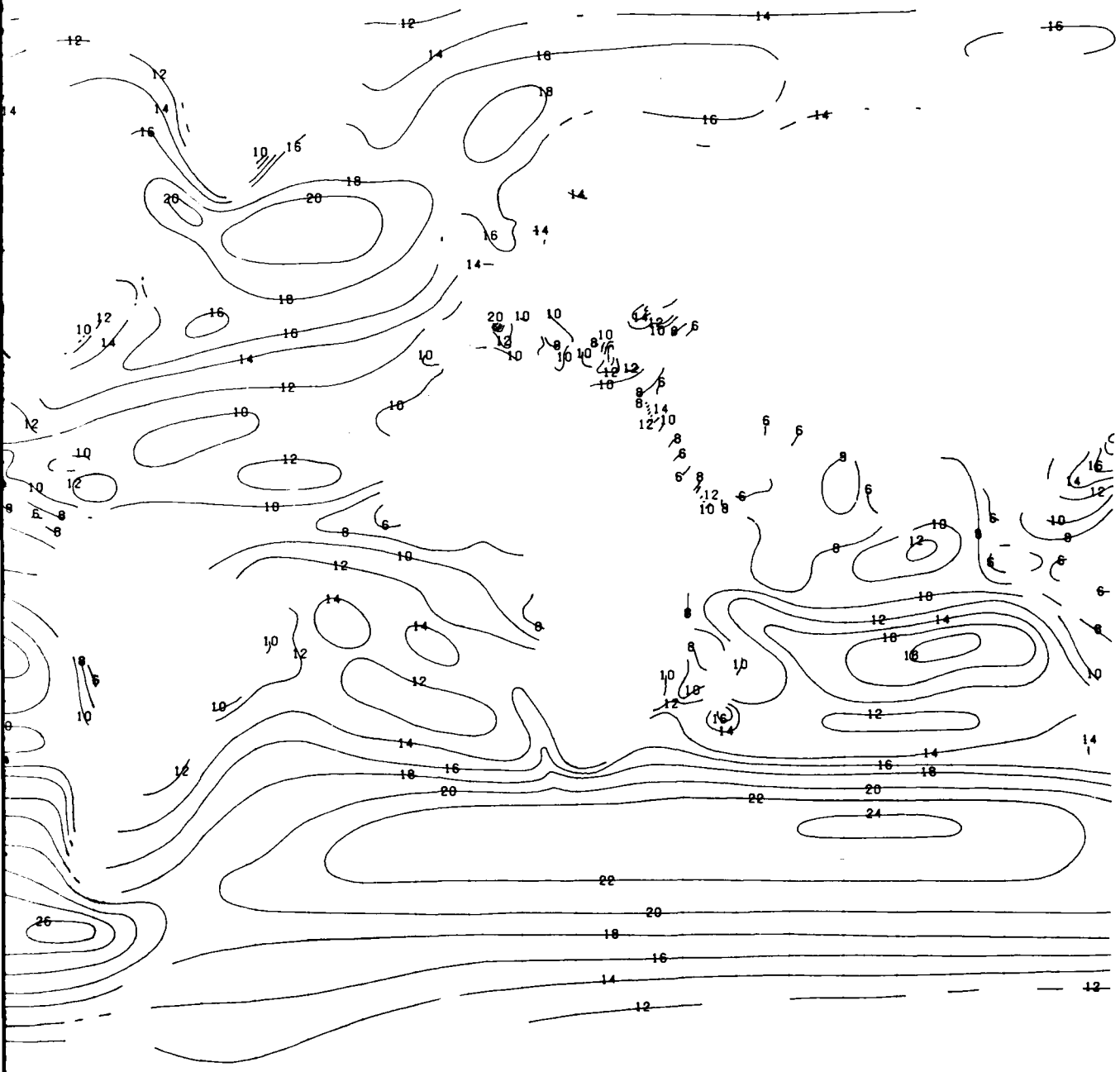
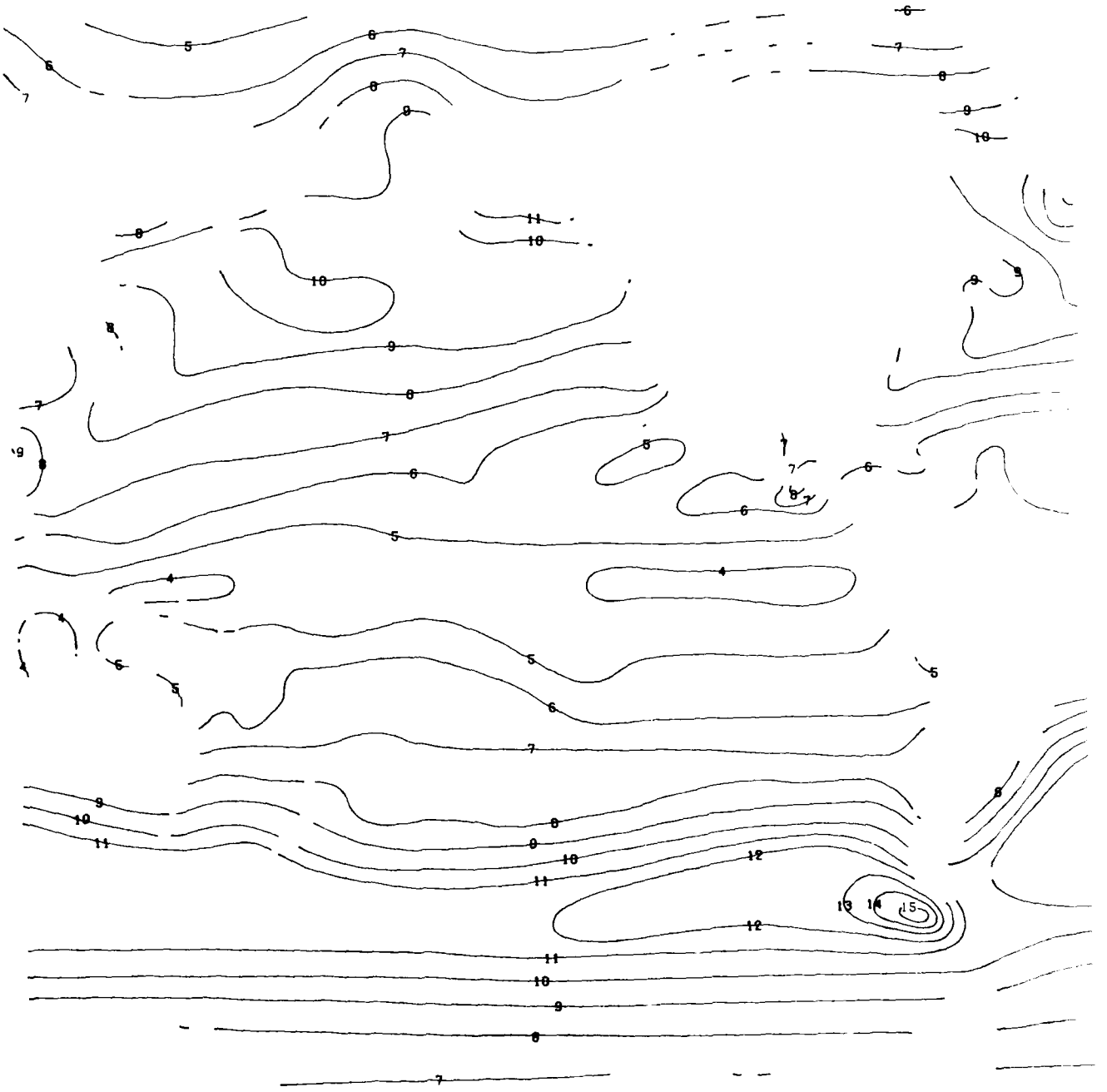


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



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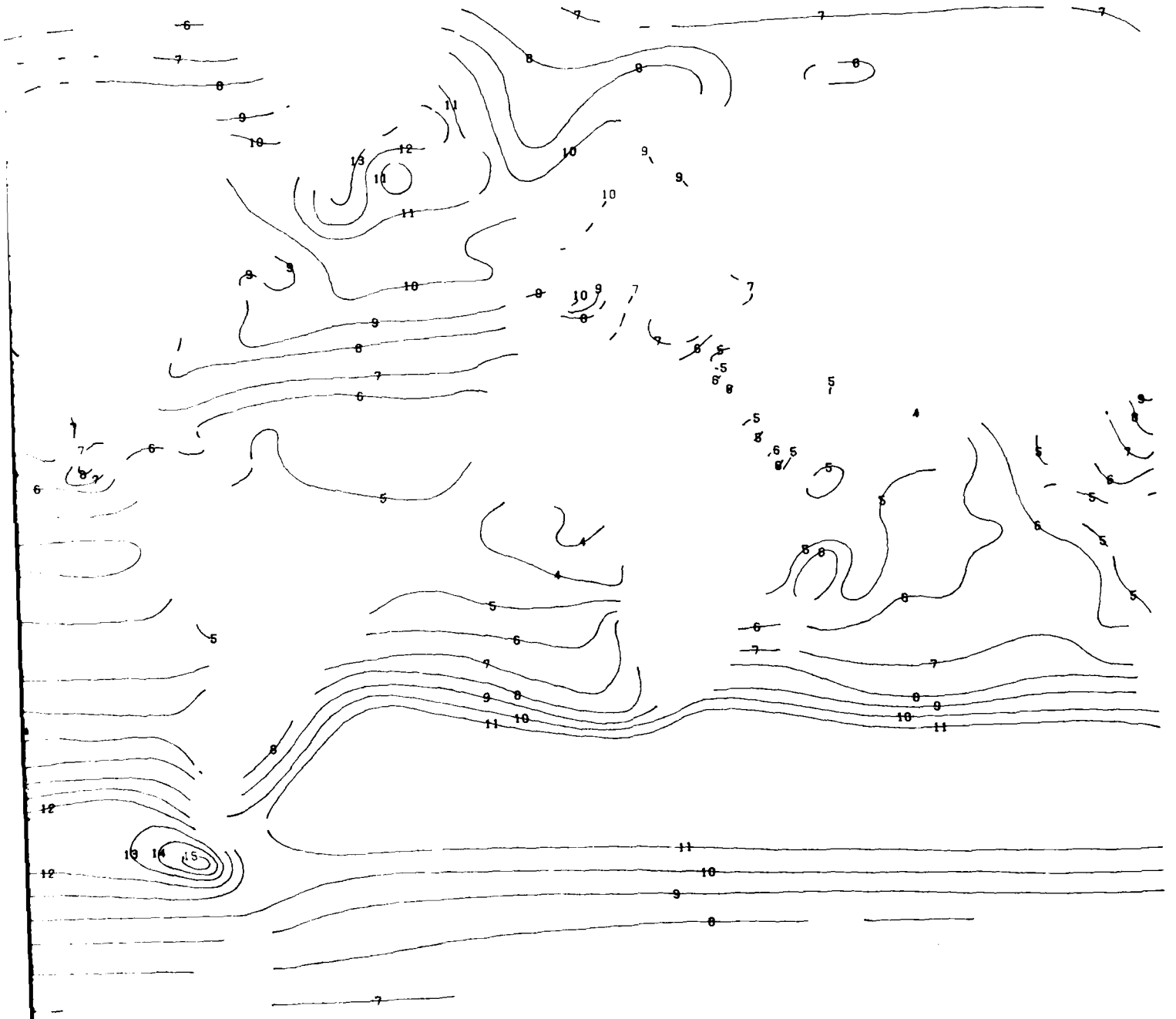

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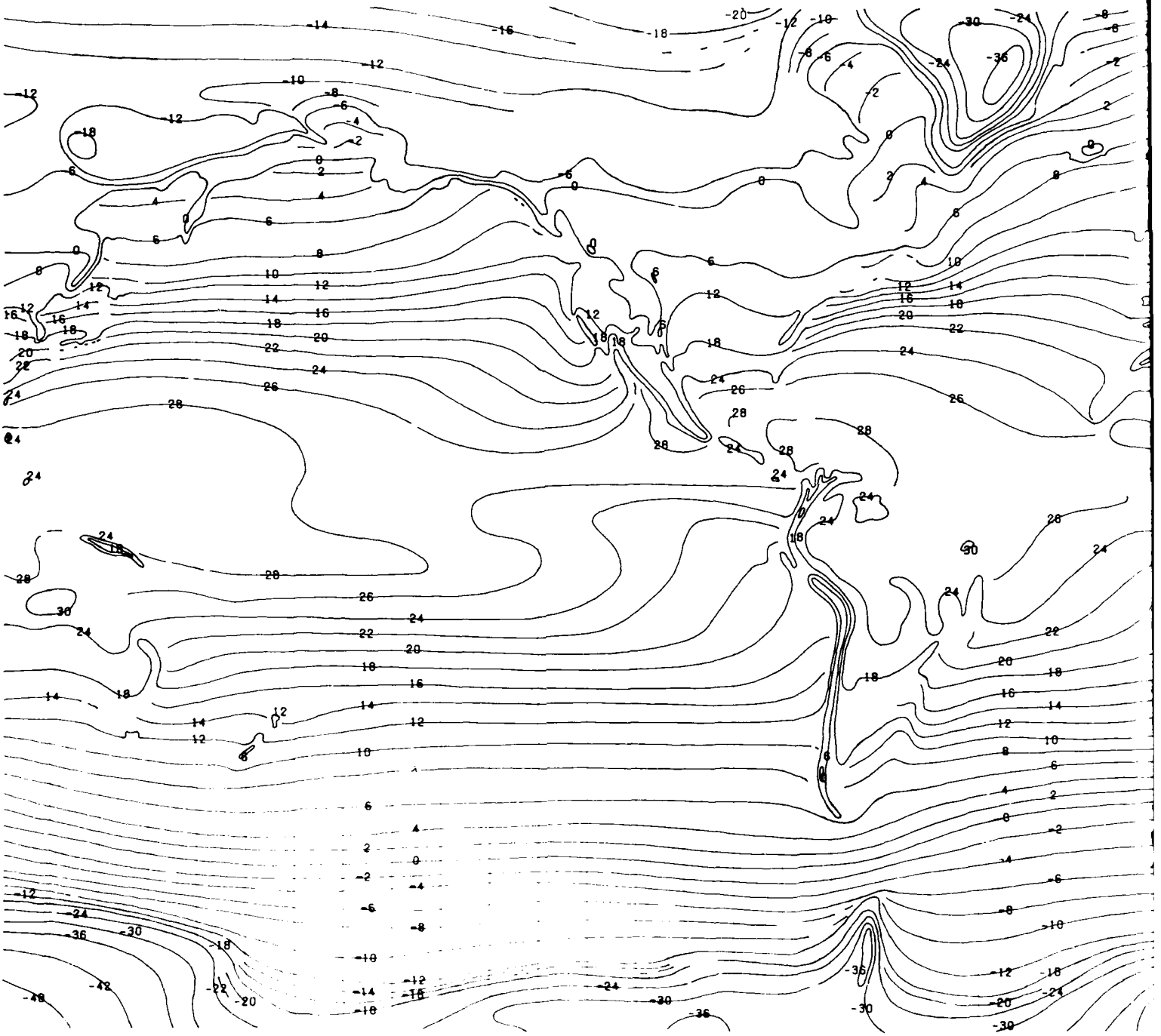
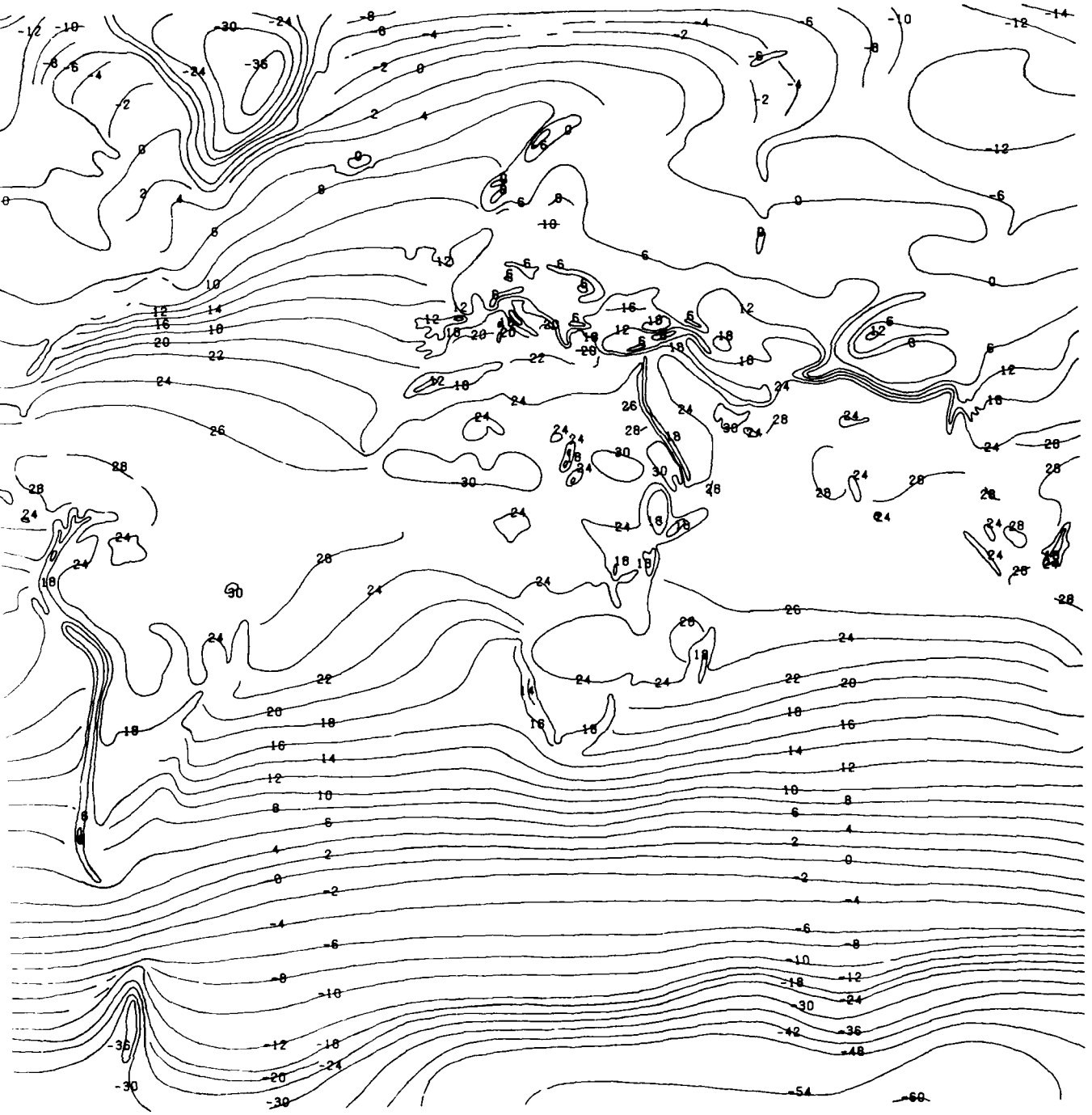
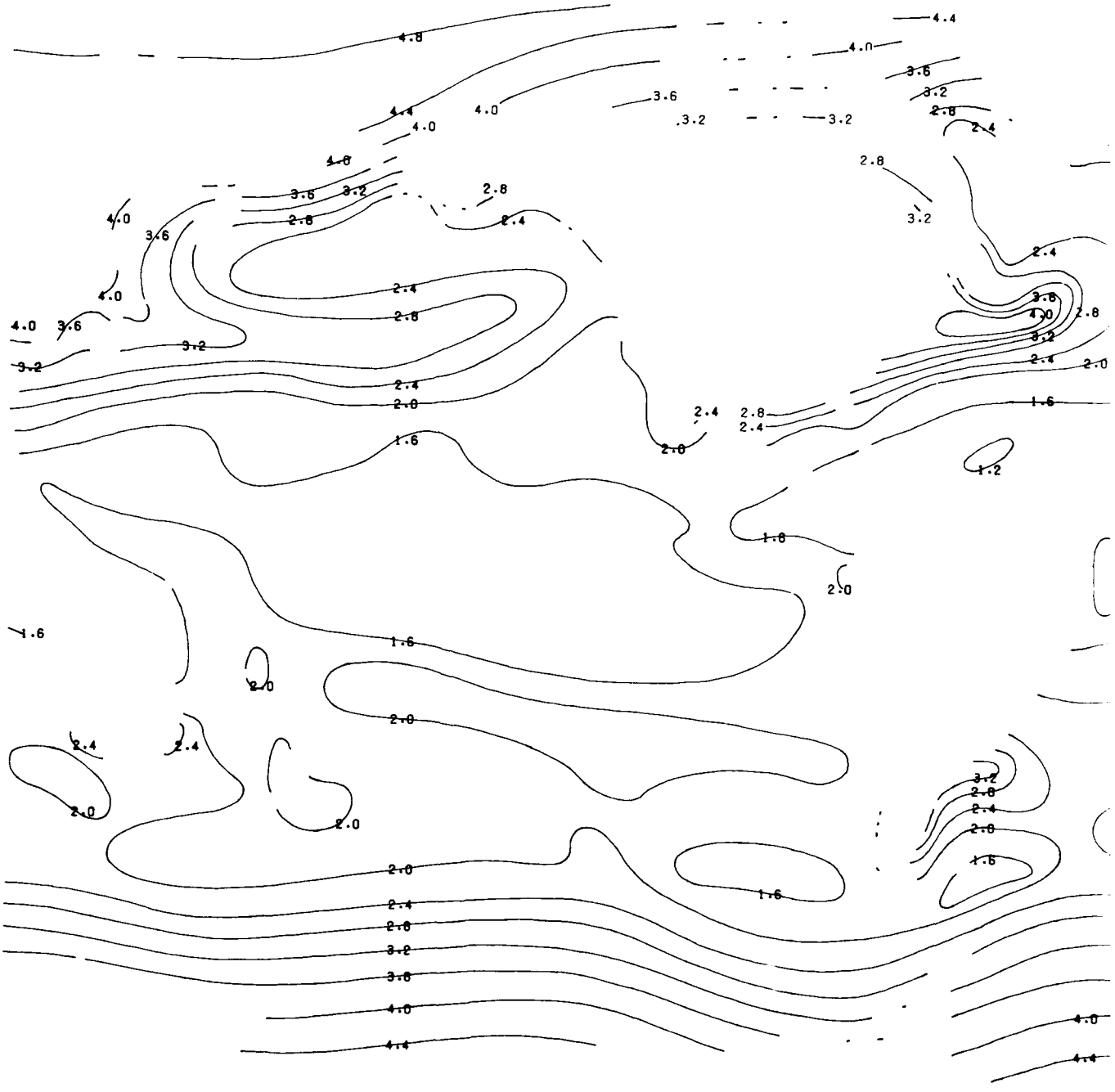


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



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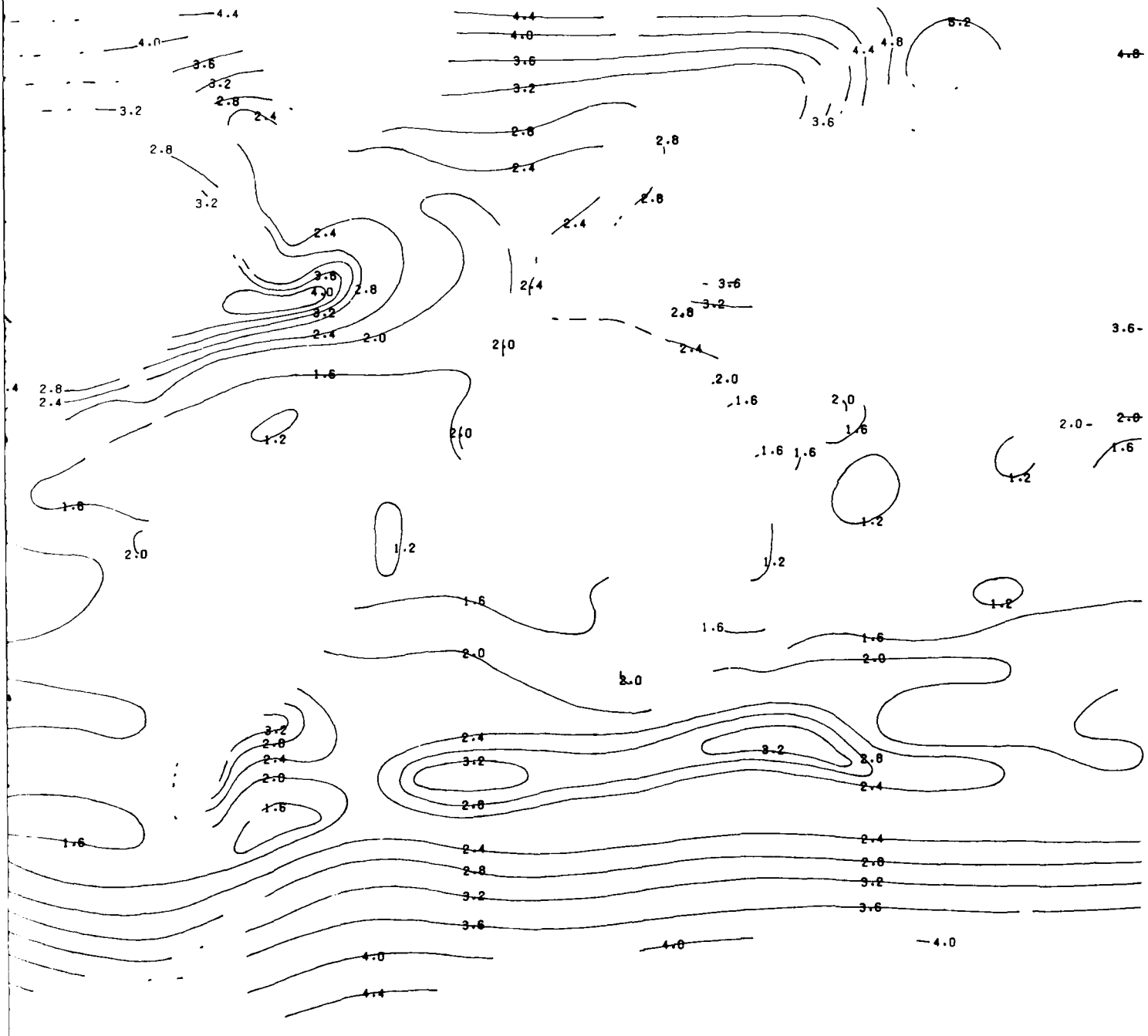

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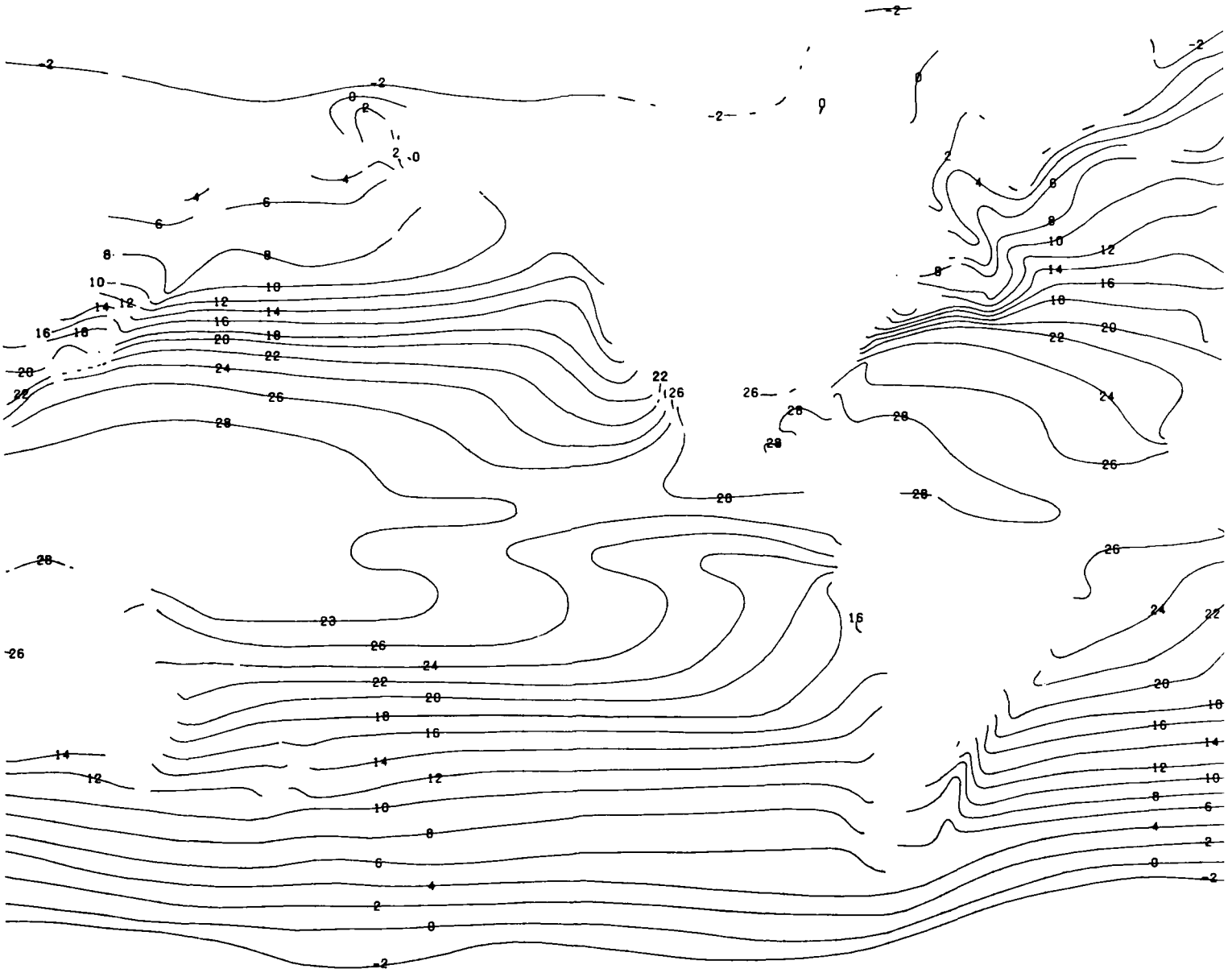
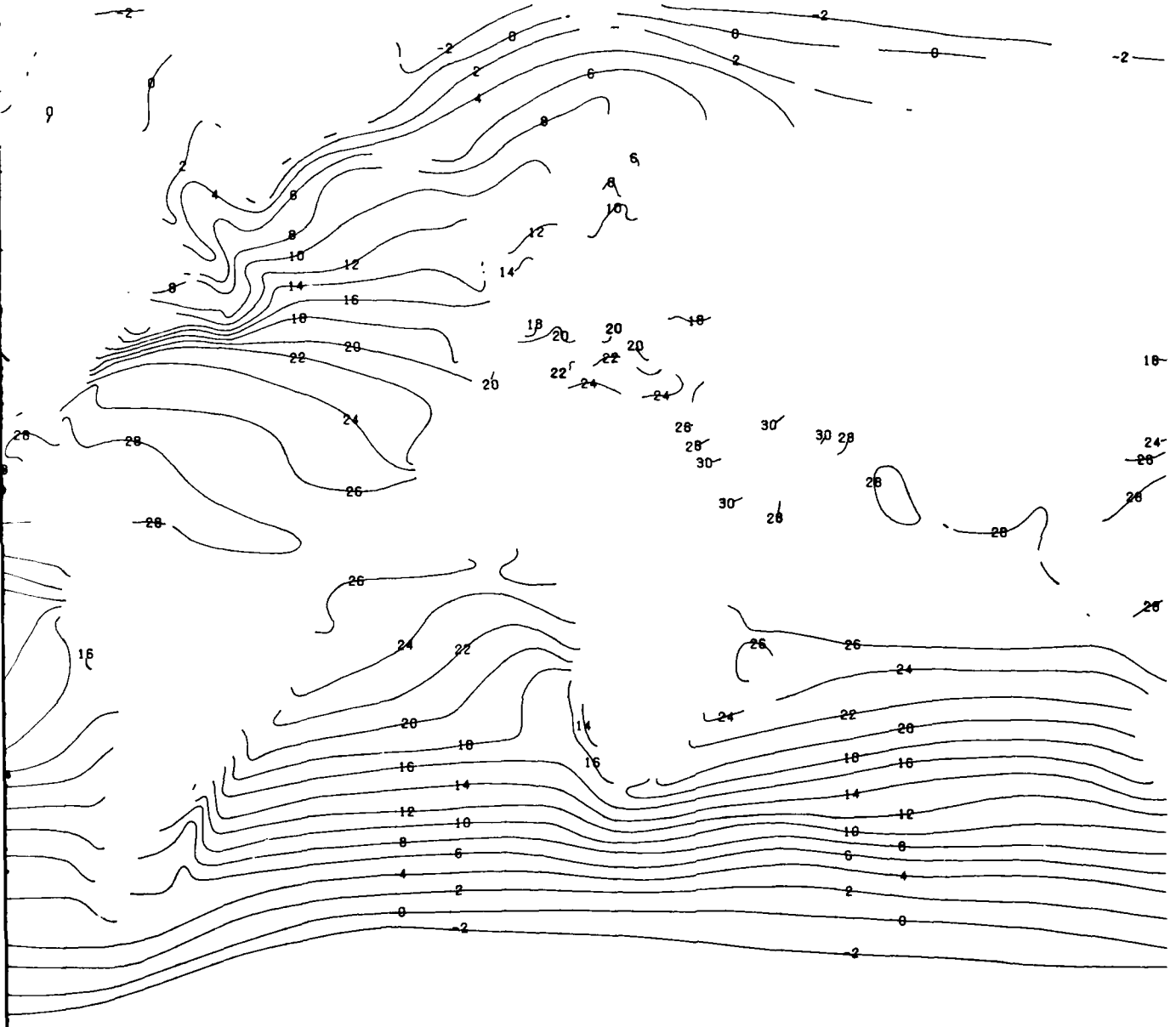
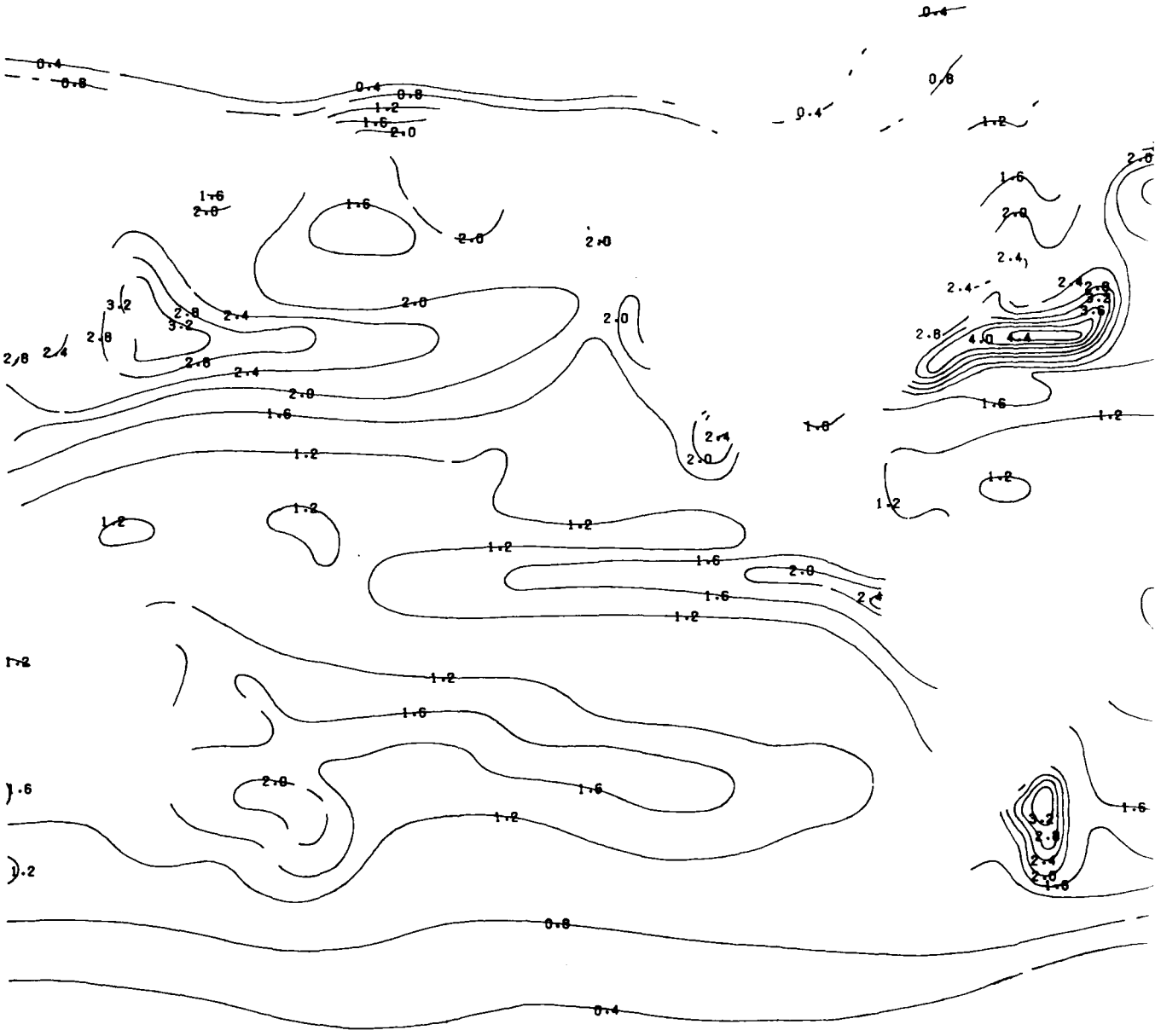


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



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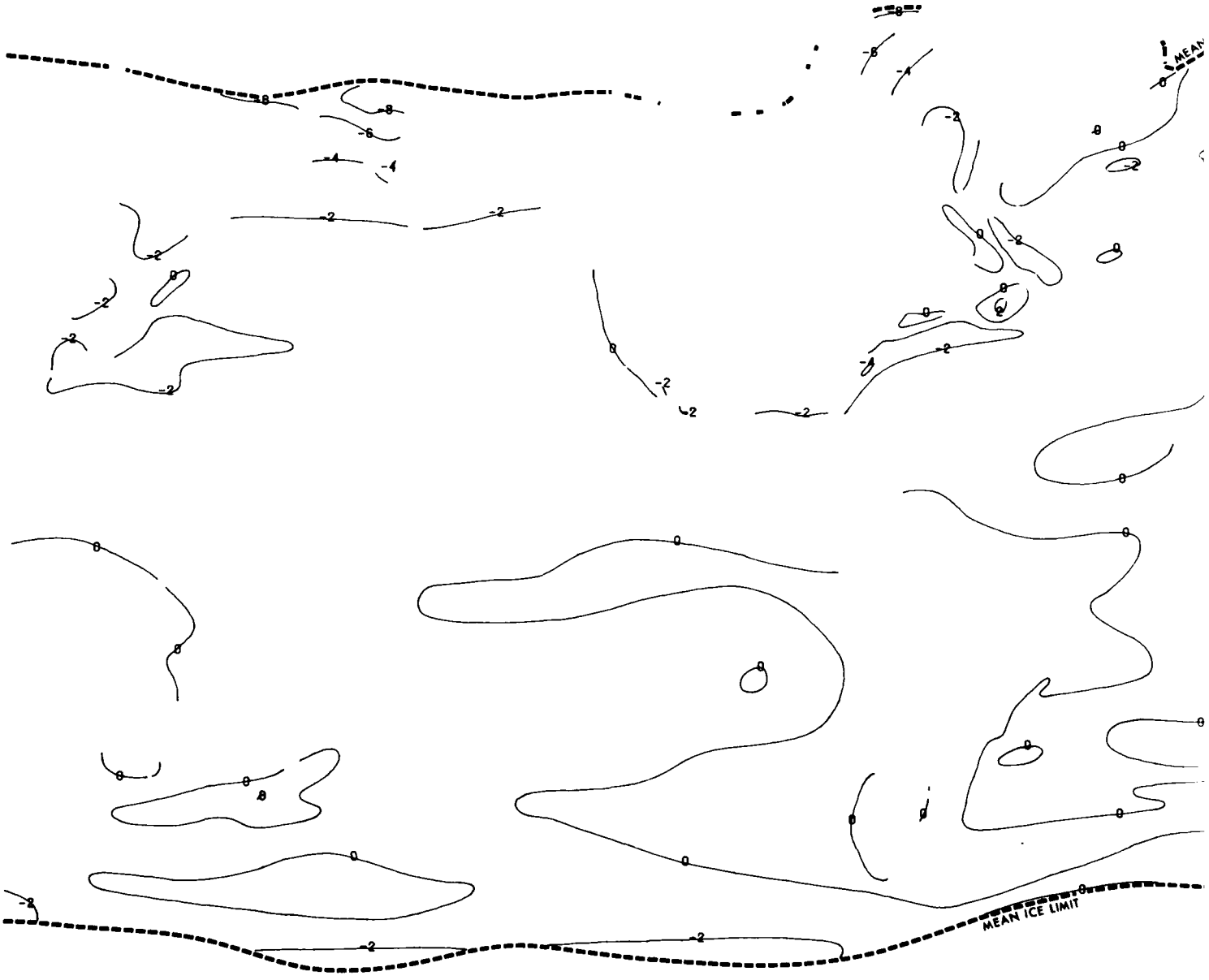
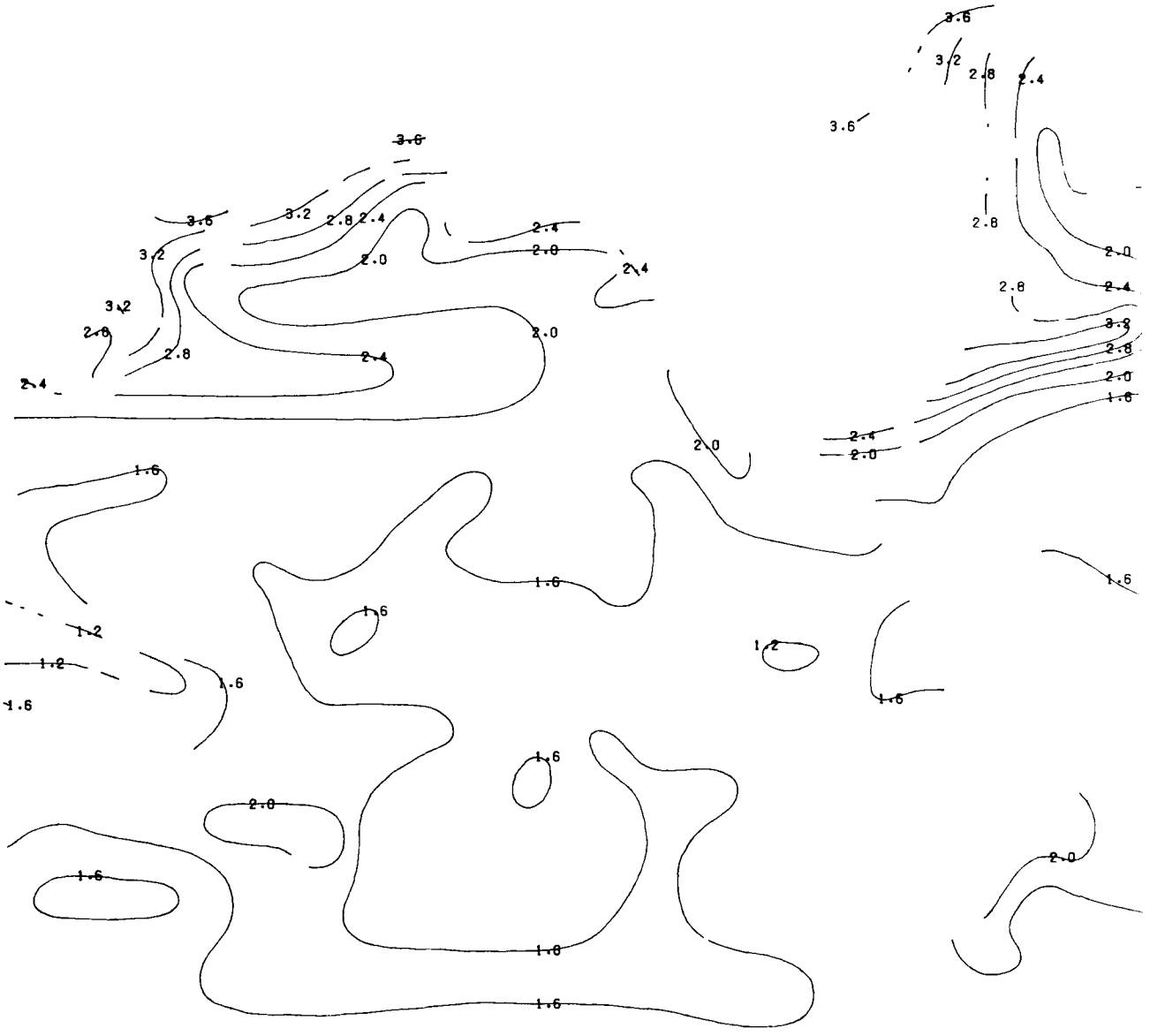


AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATI



- STANDARD DEVIATIONS

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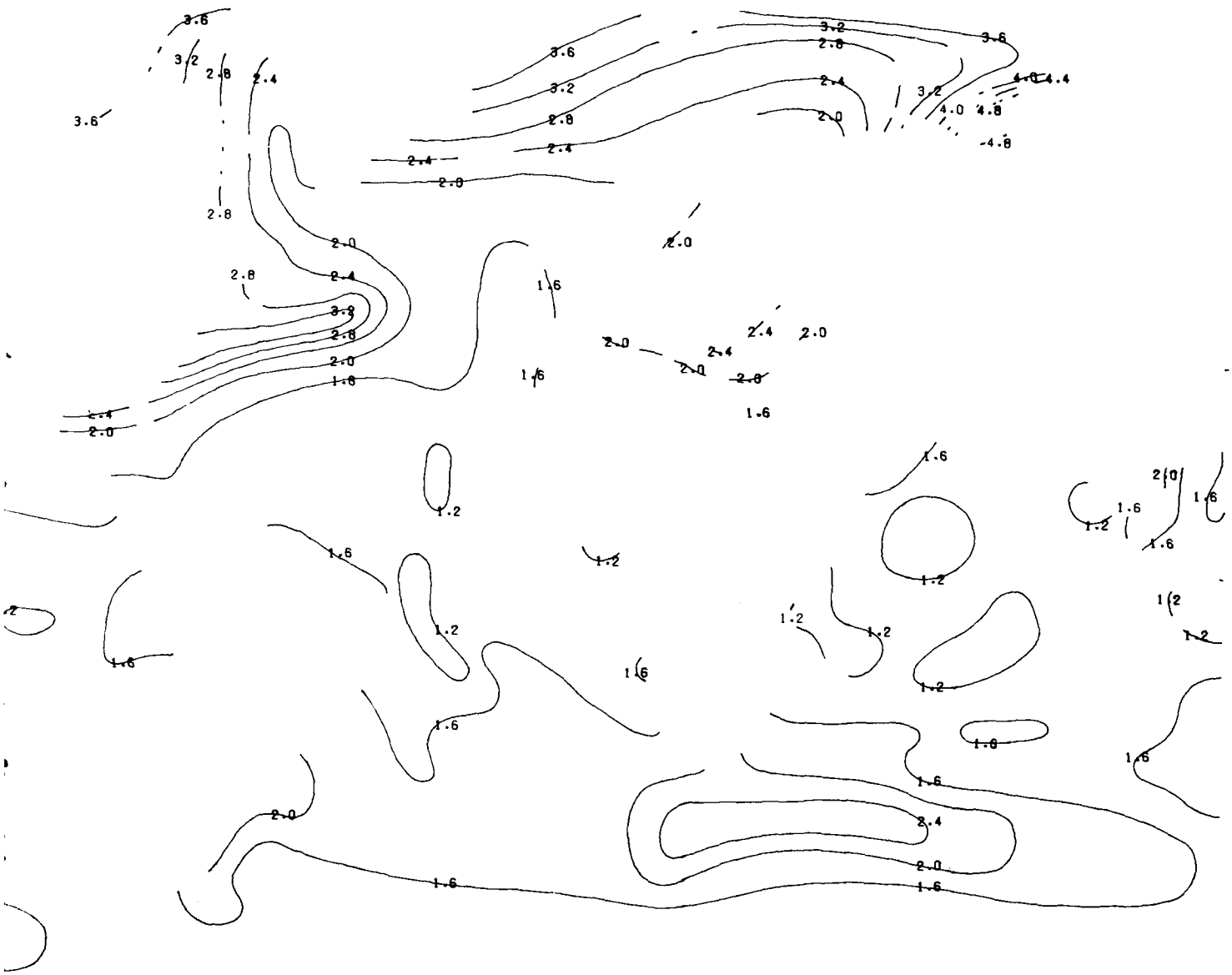

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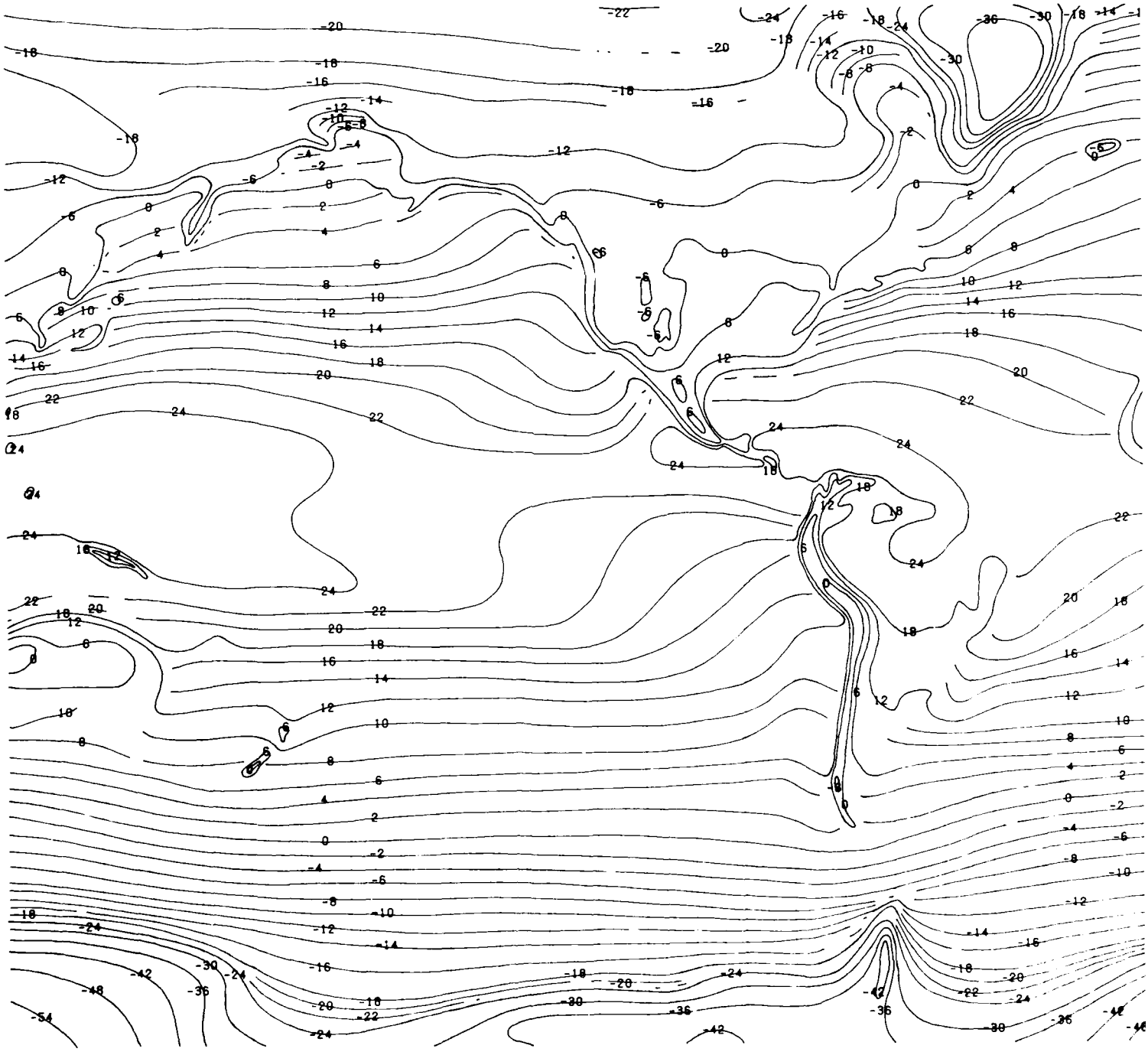
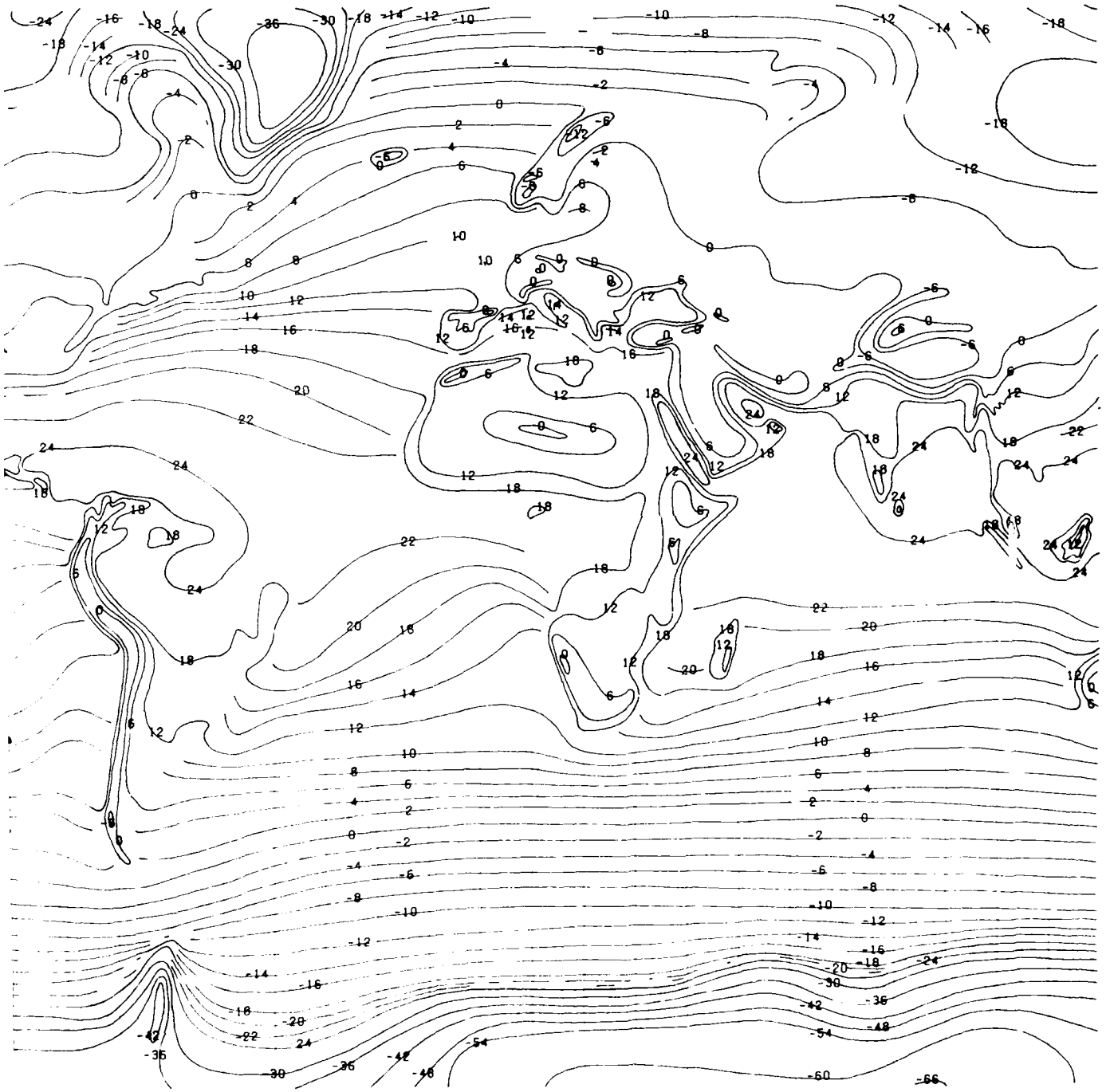
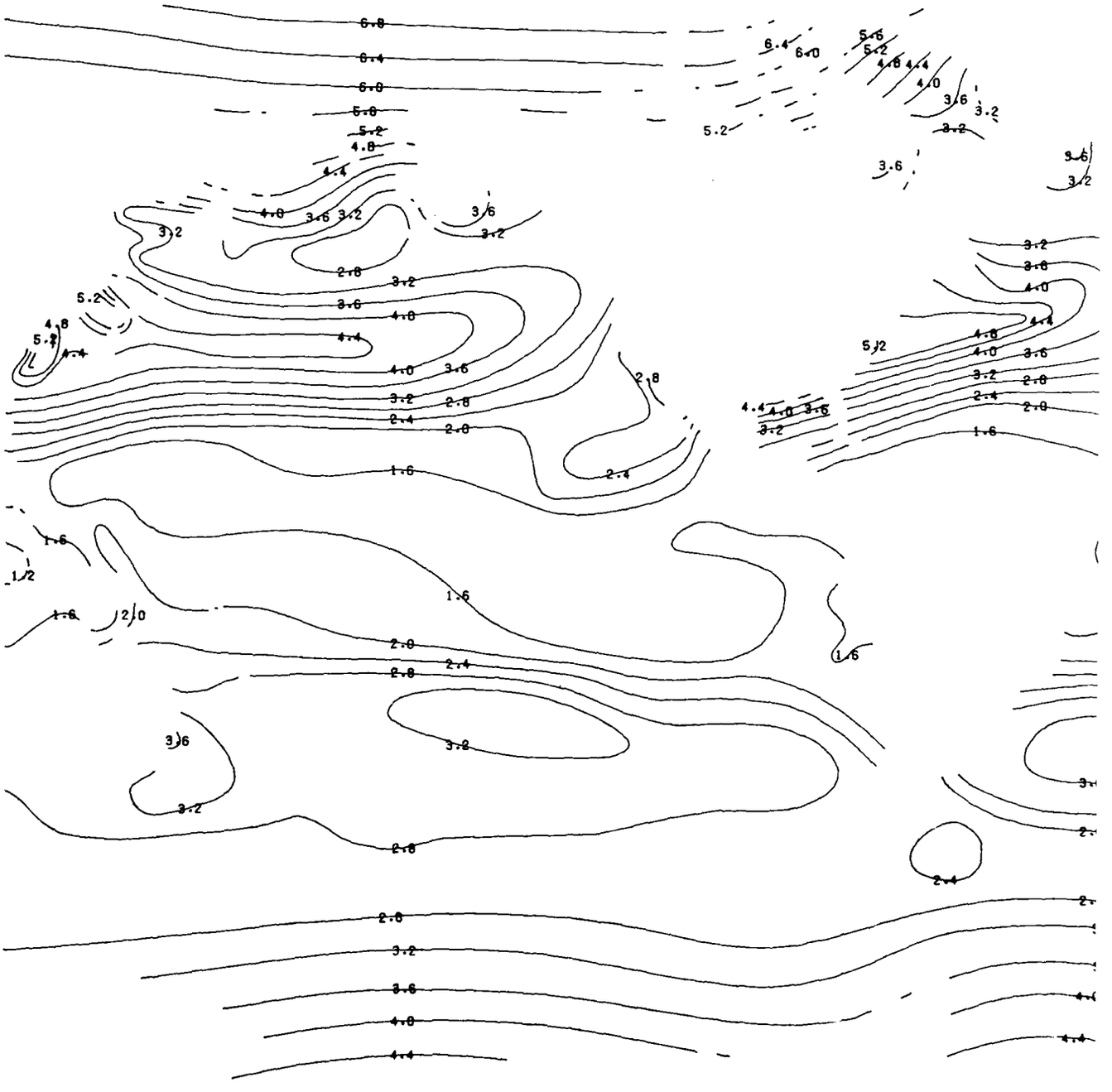


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



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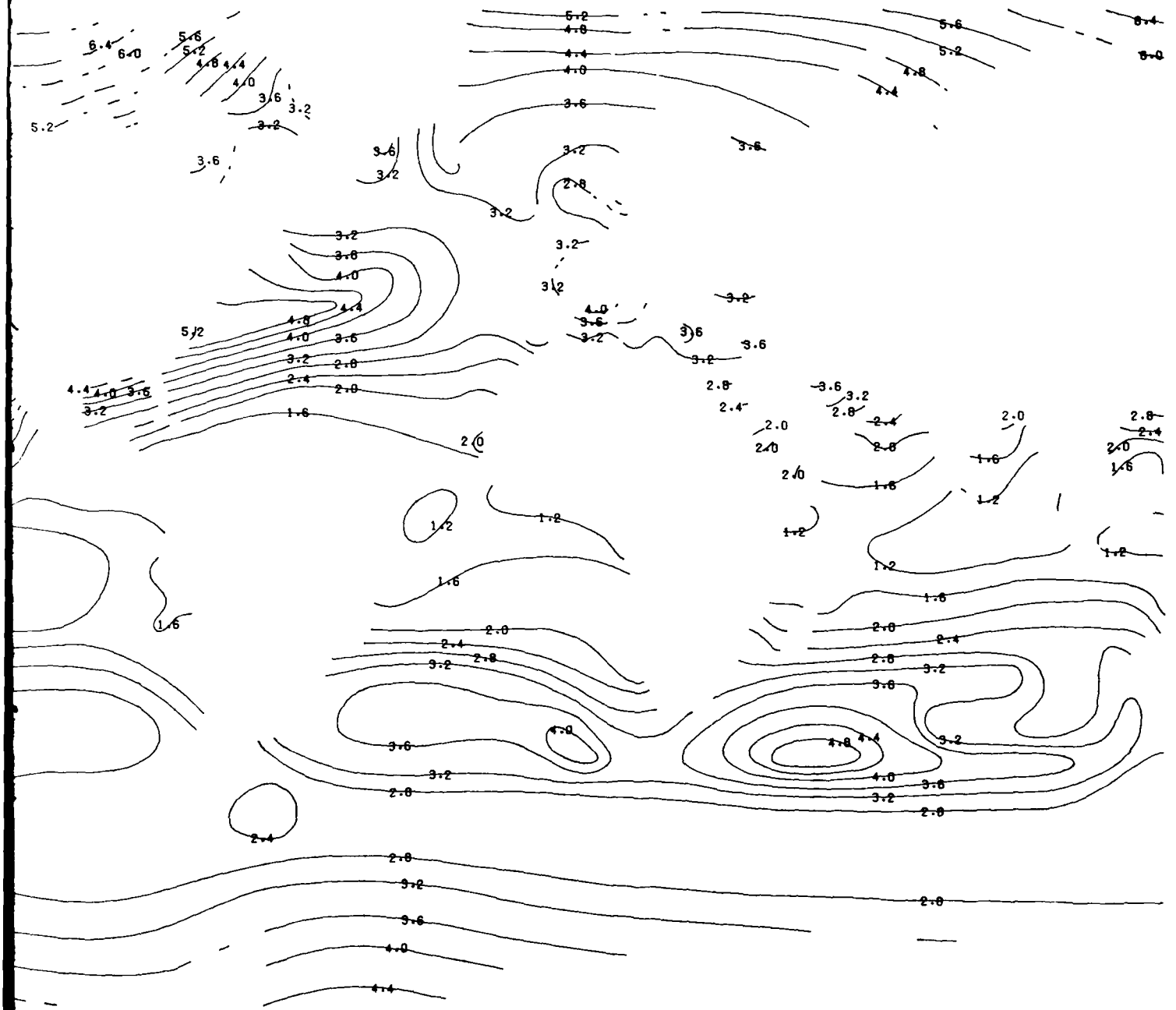

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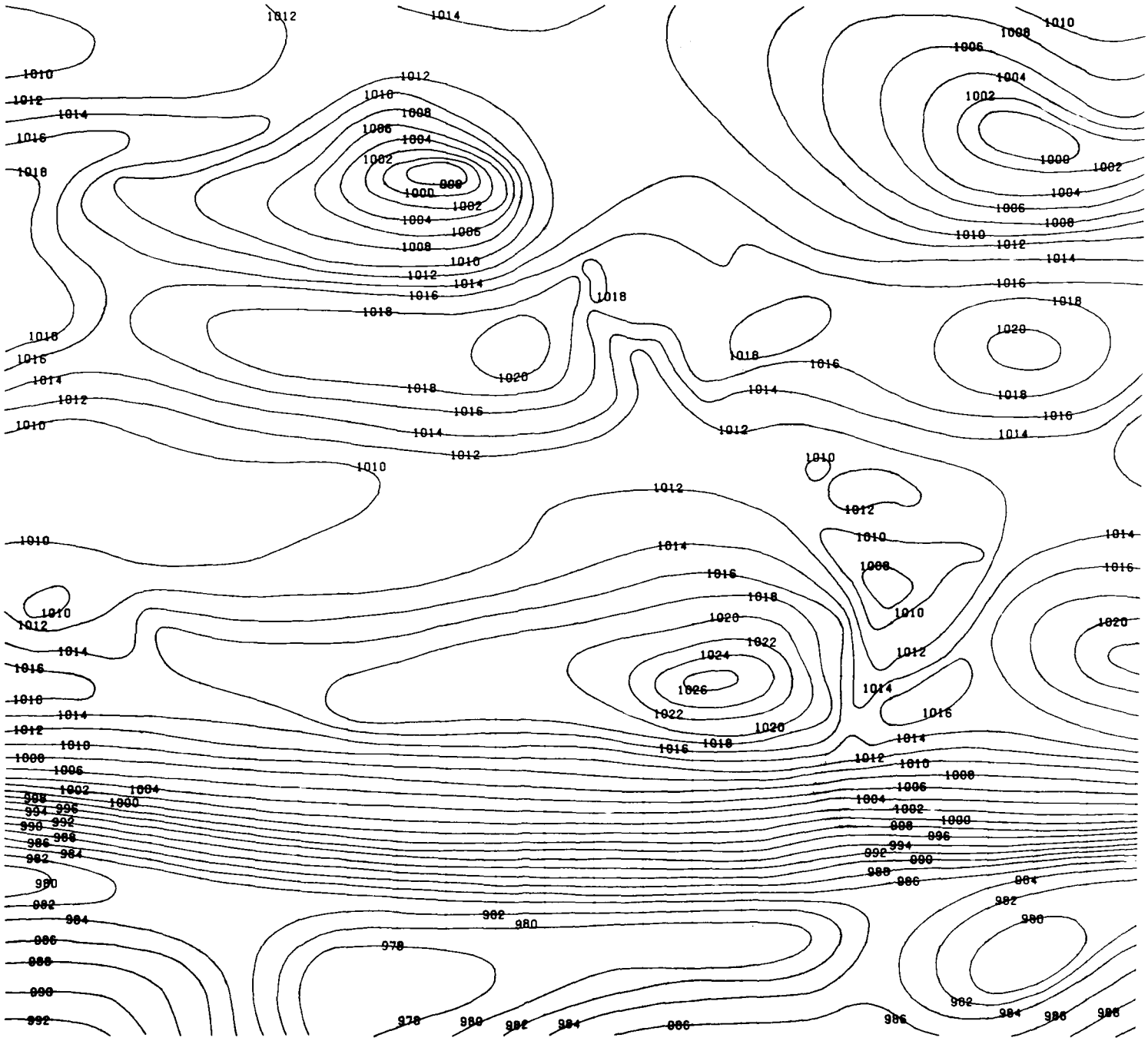
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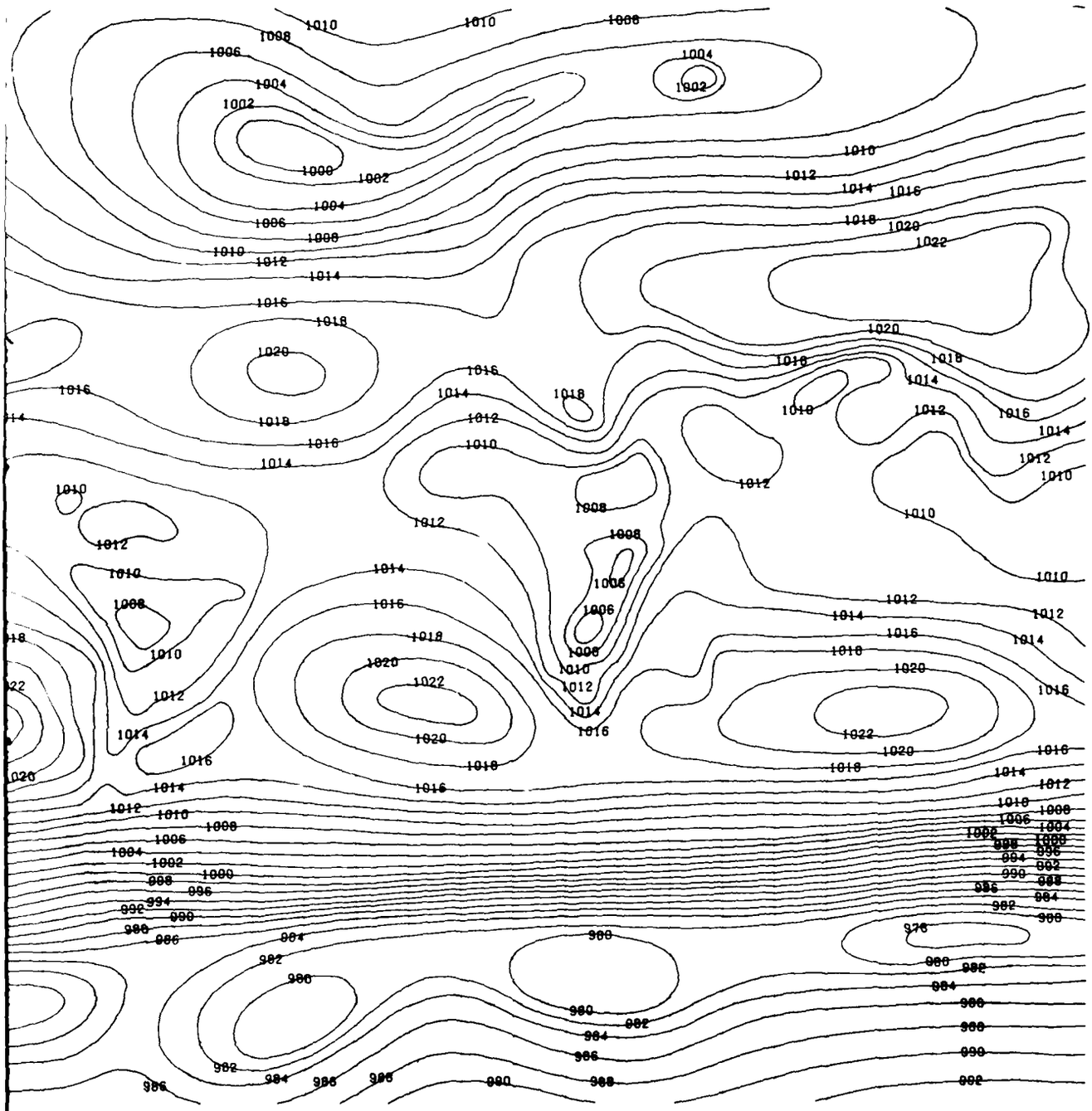
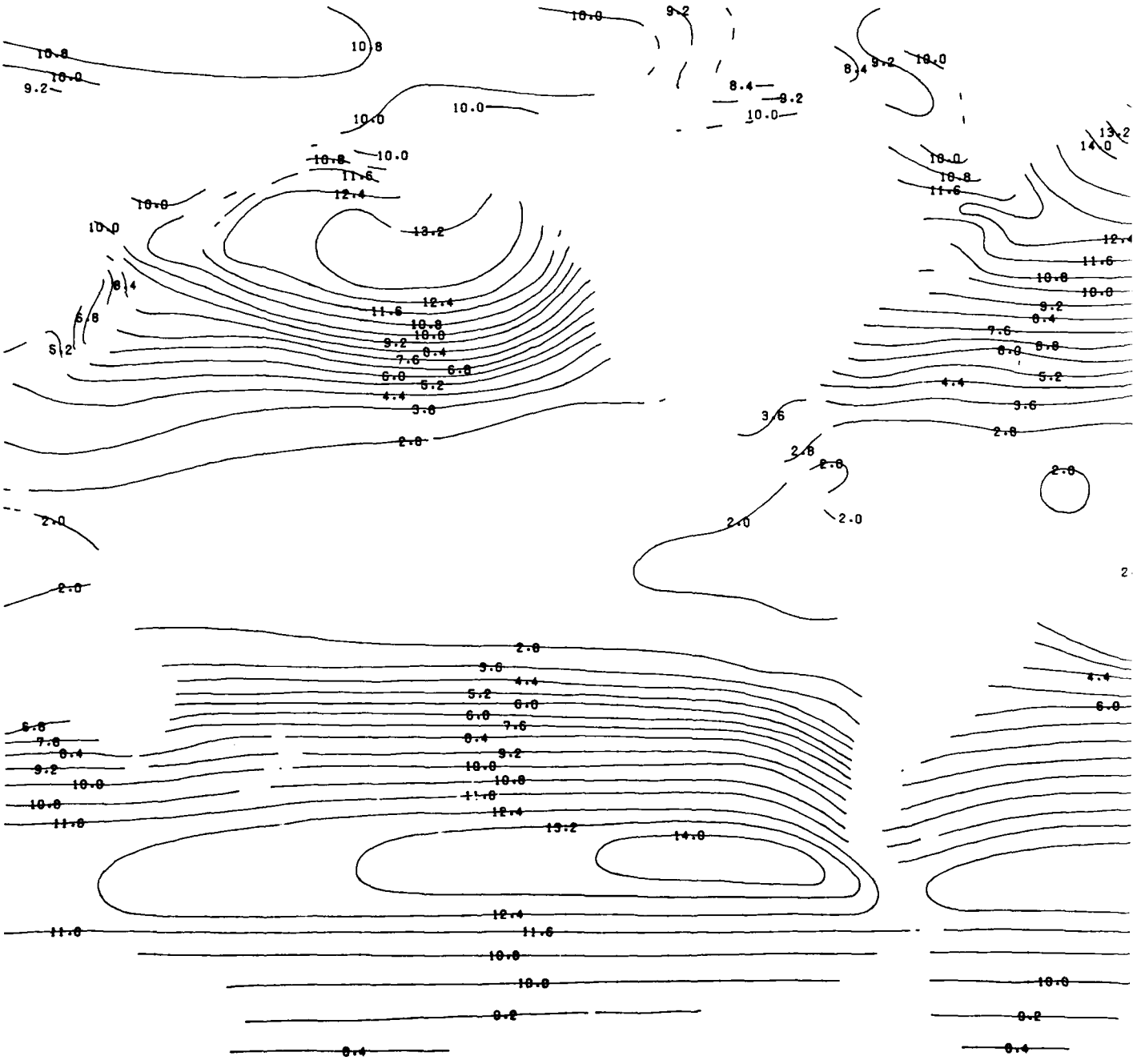
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



D DEVIATIONS

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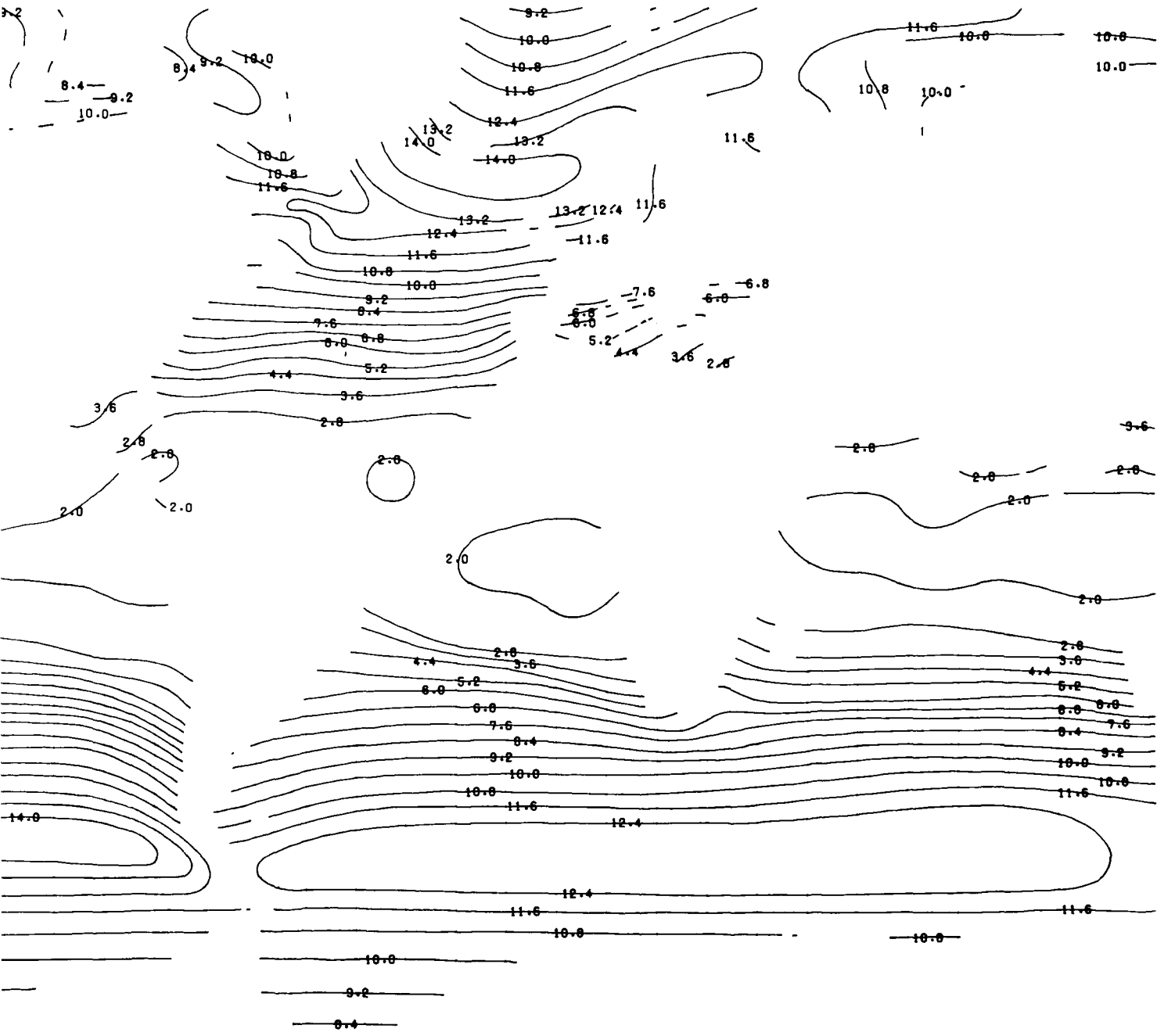

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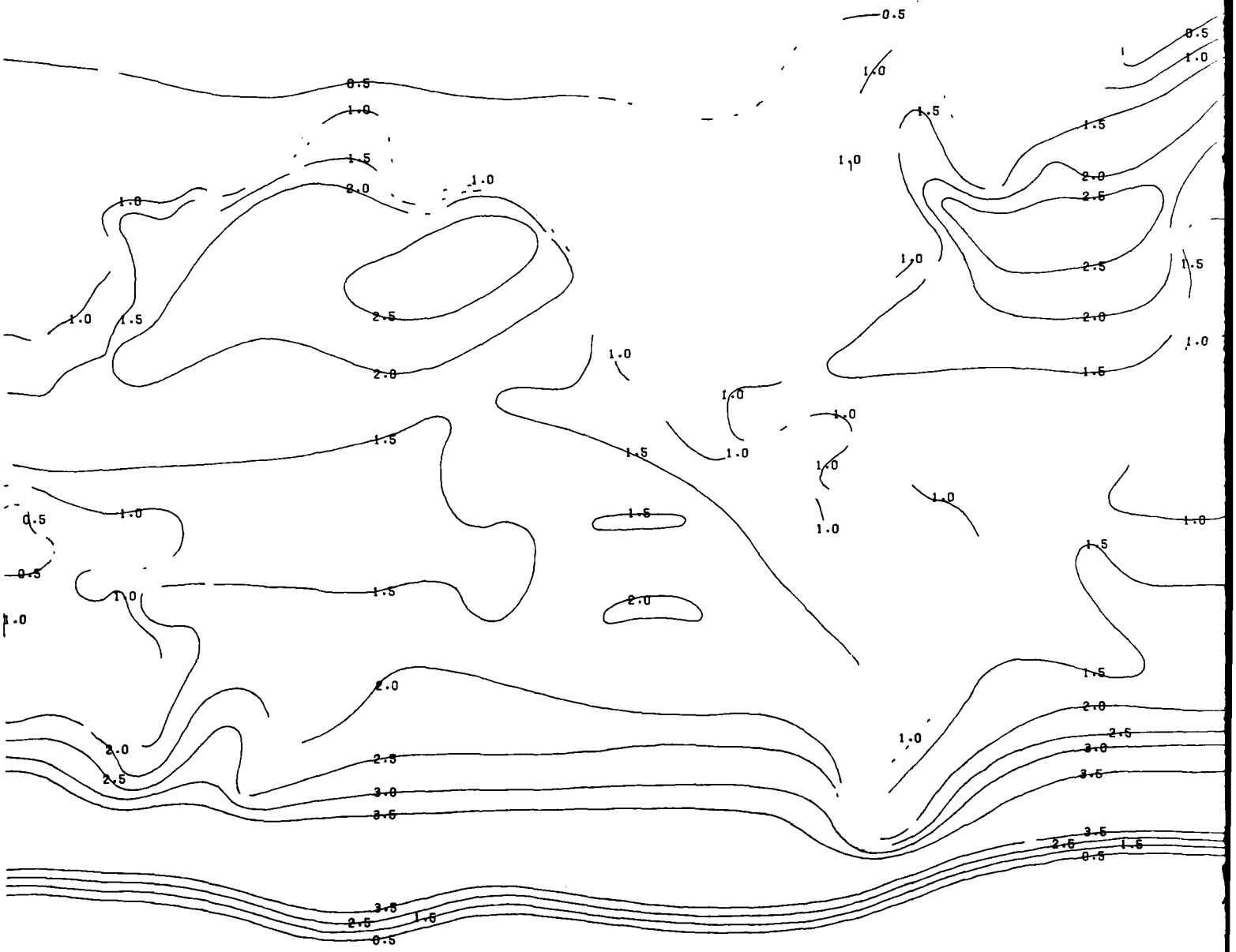
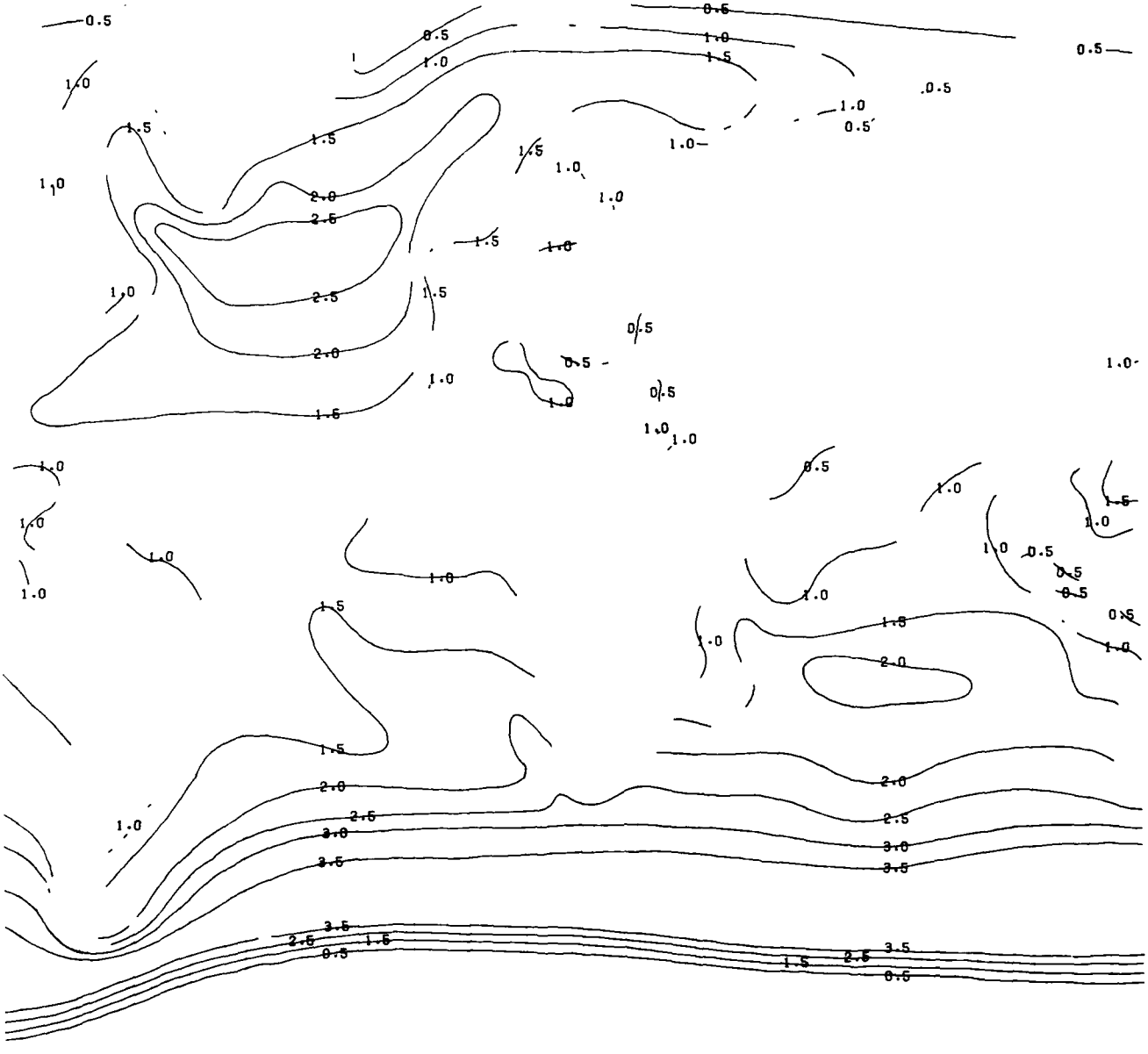
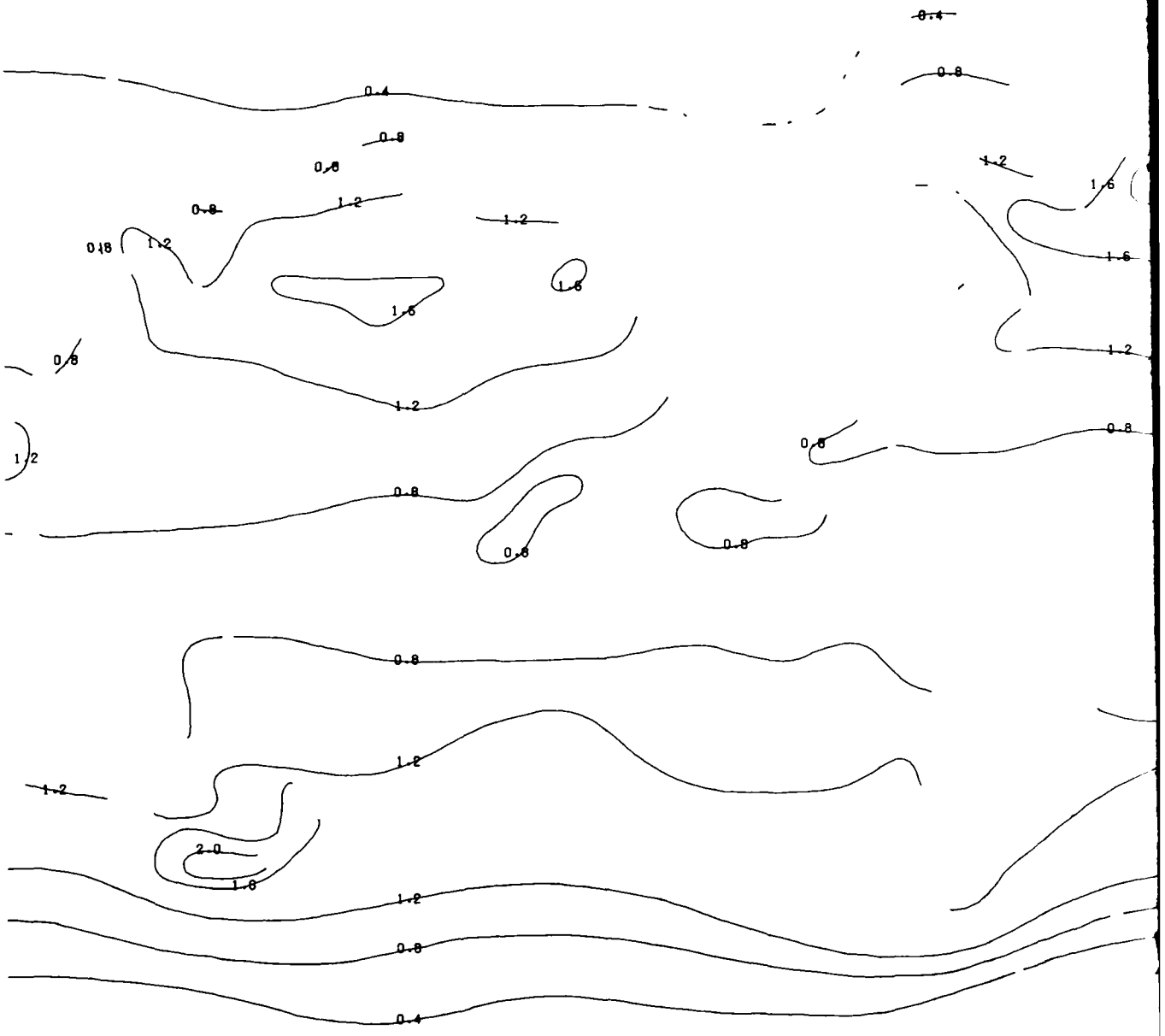


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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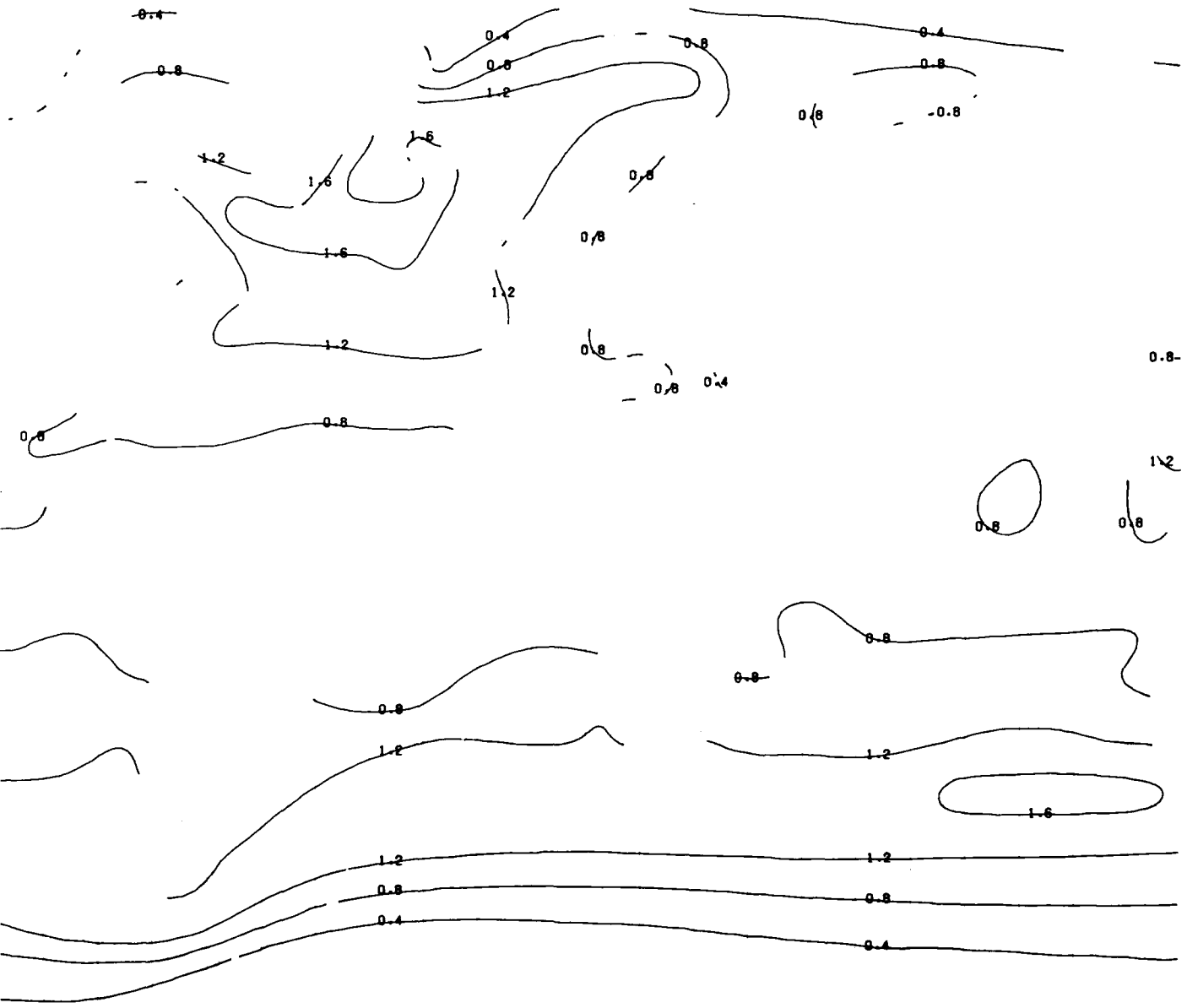

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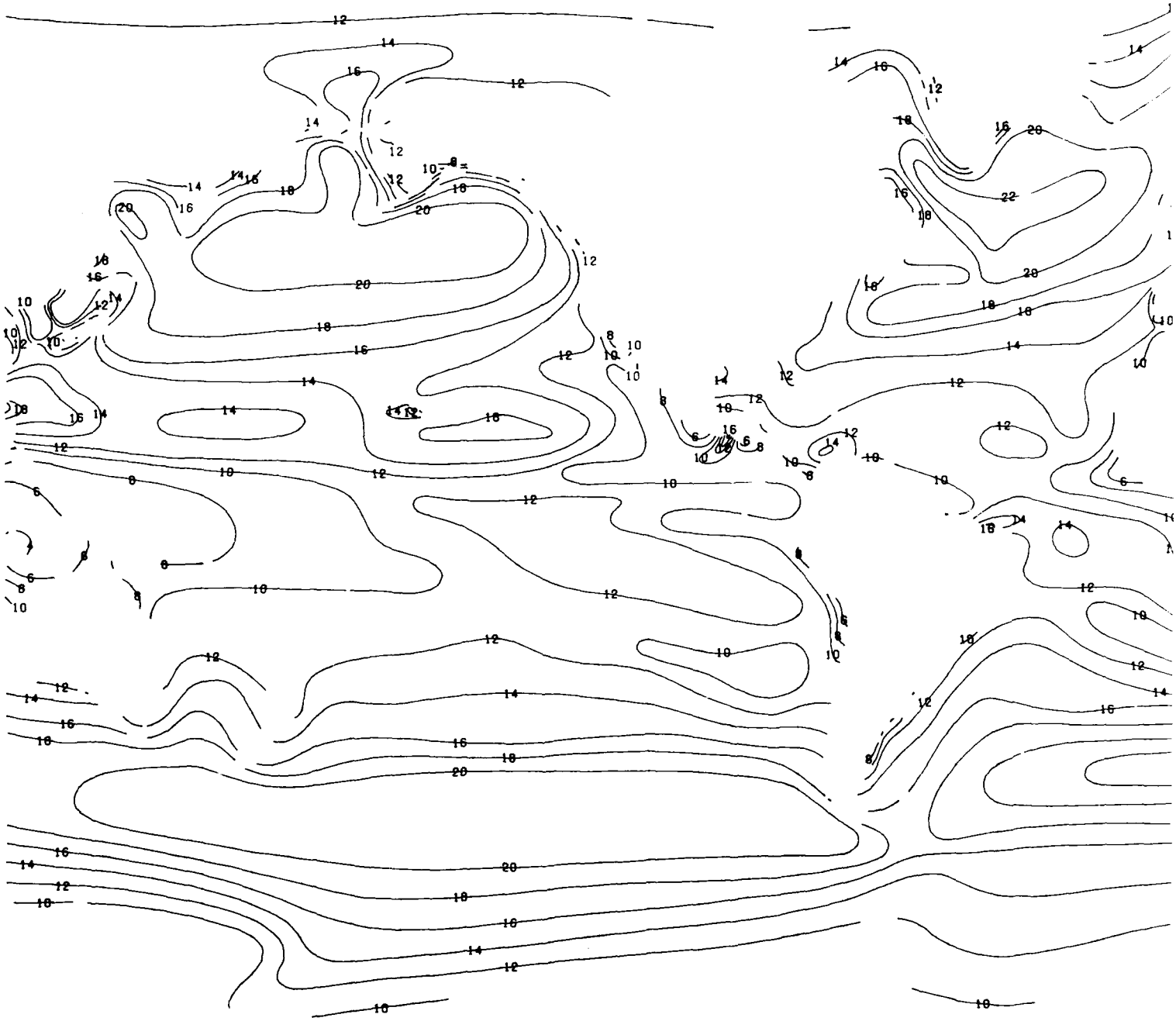
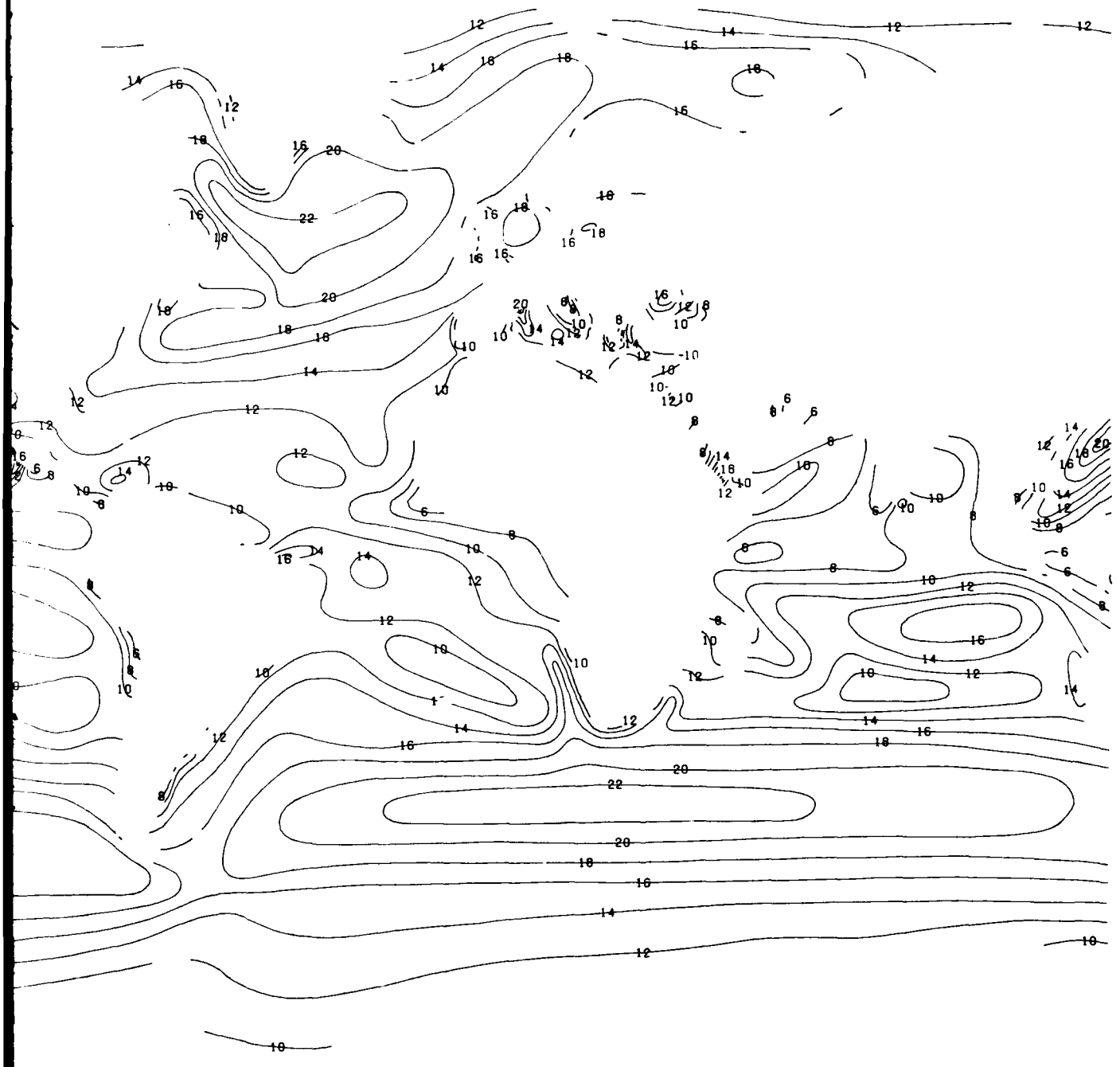
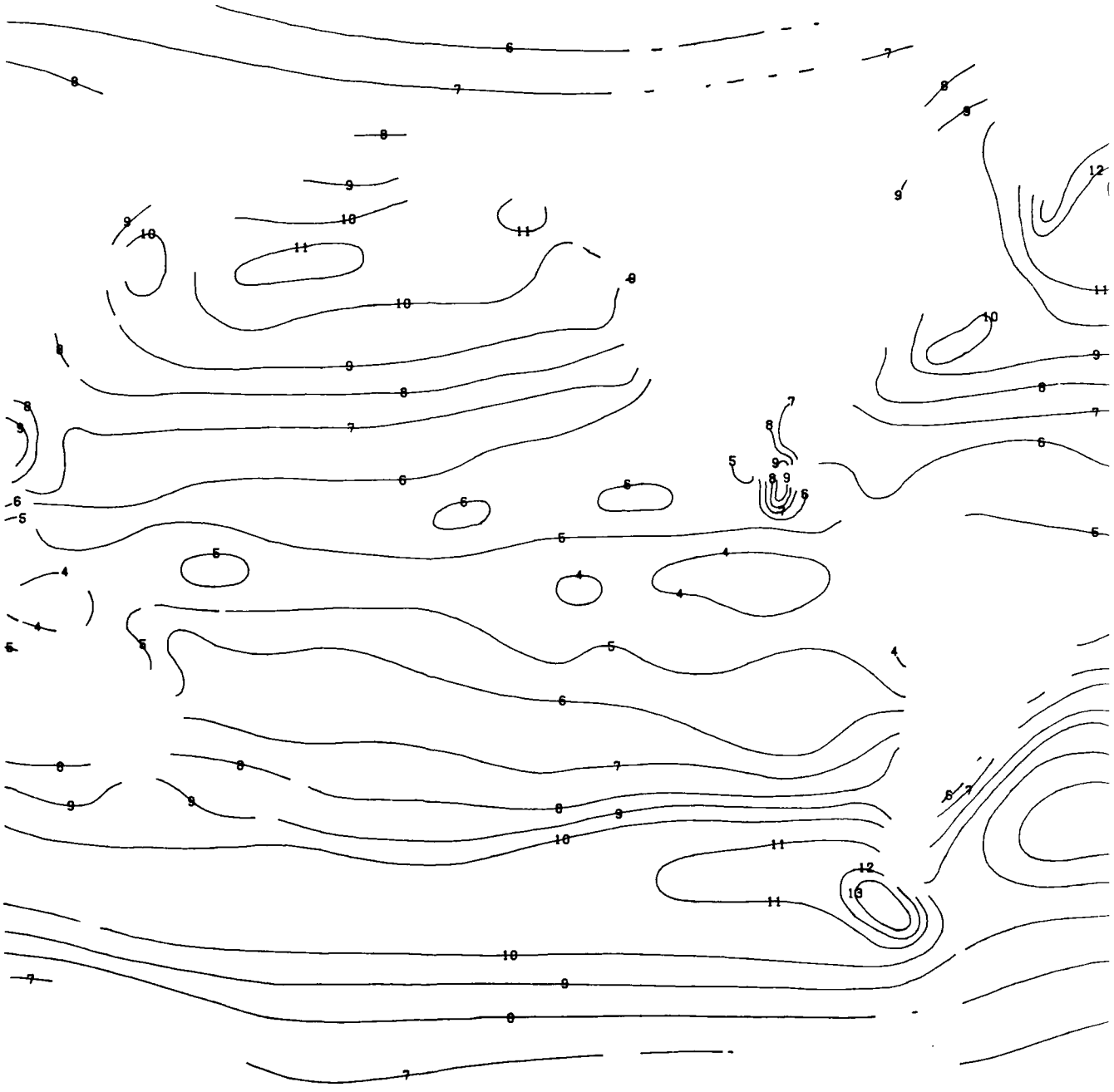
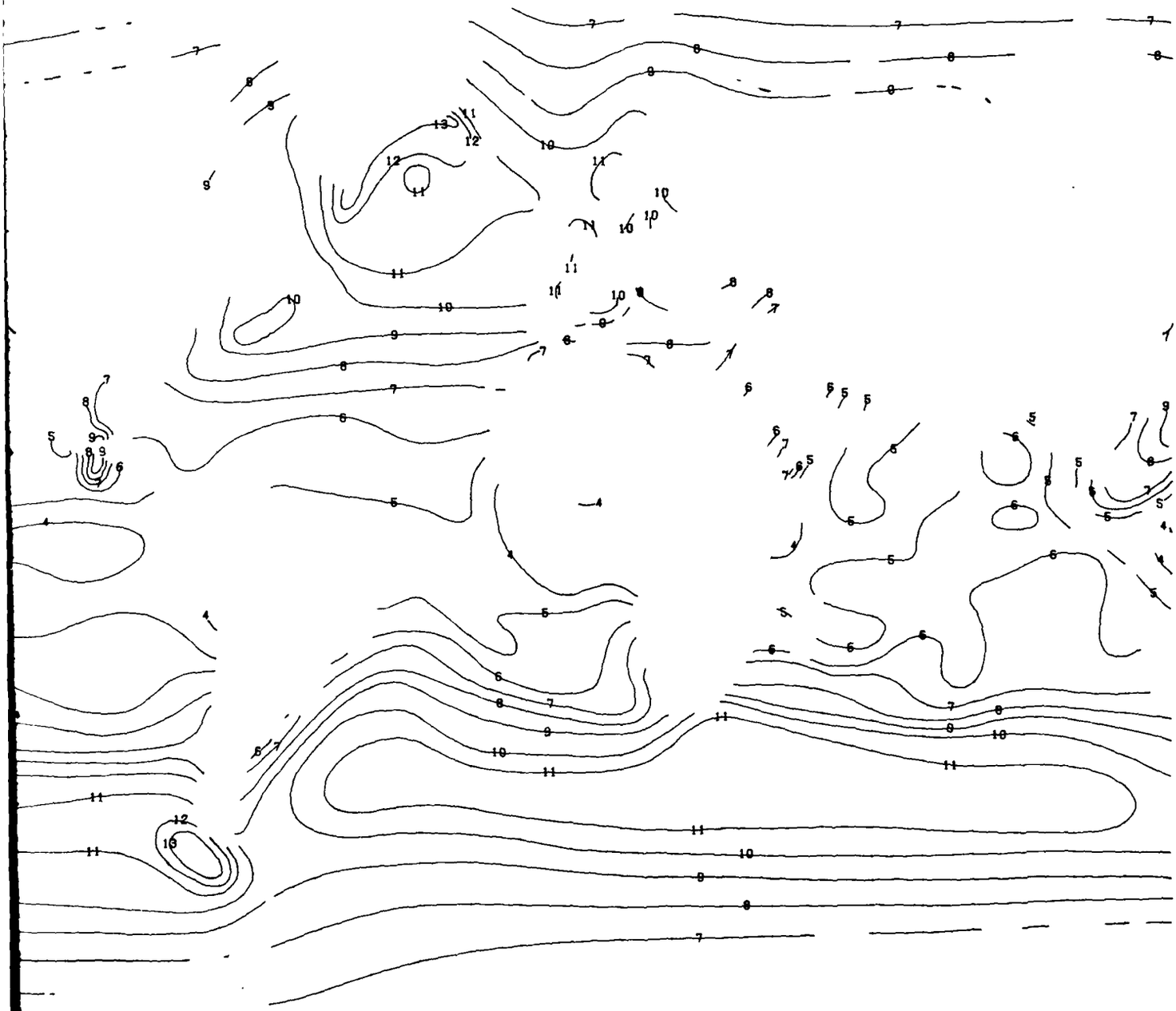


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS





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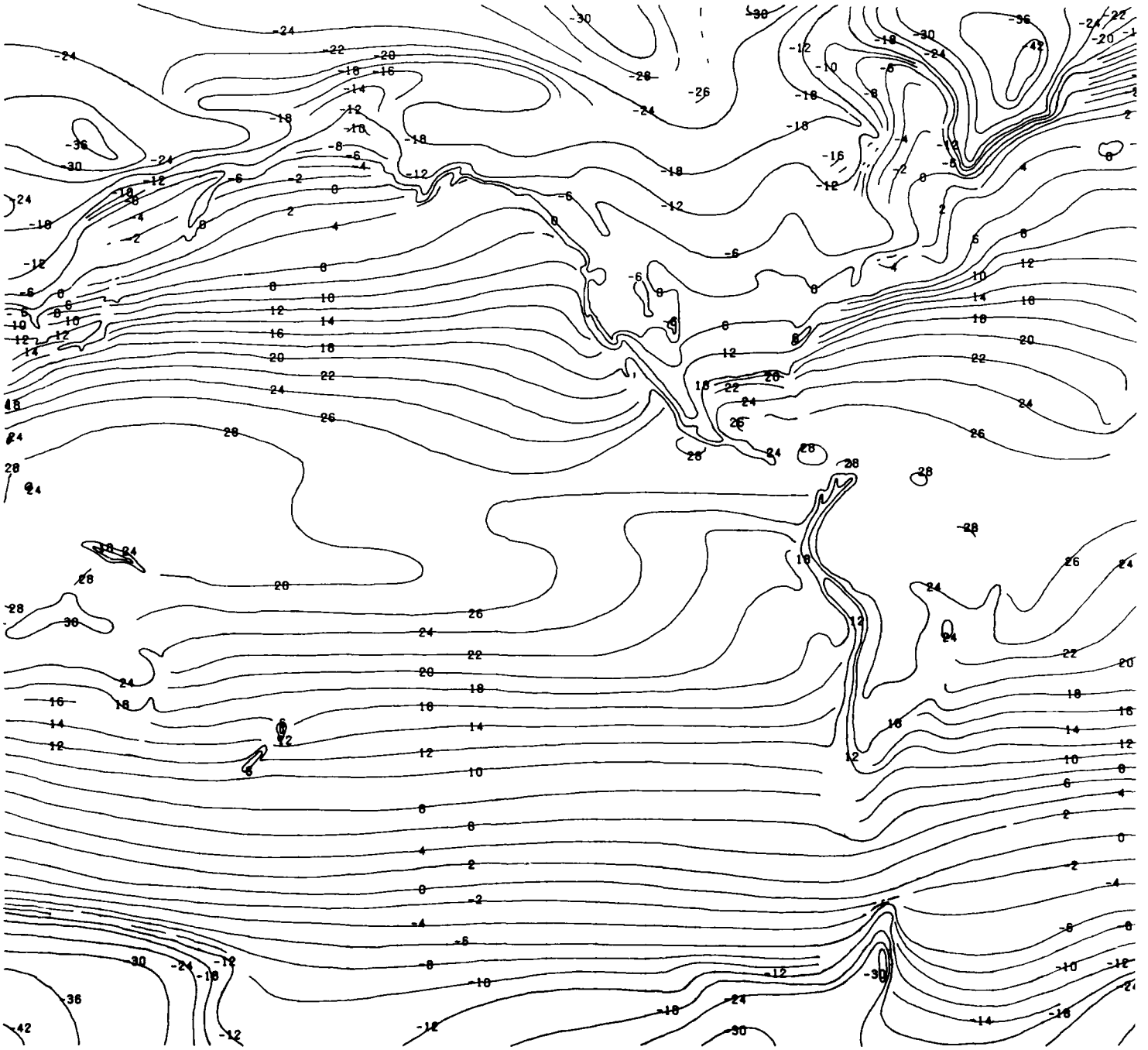
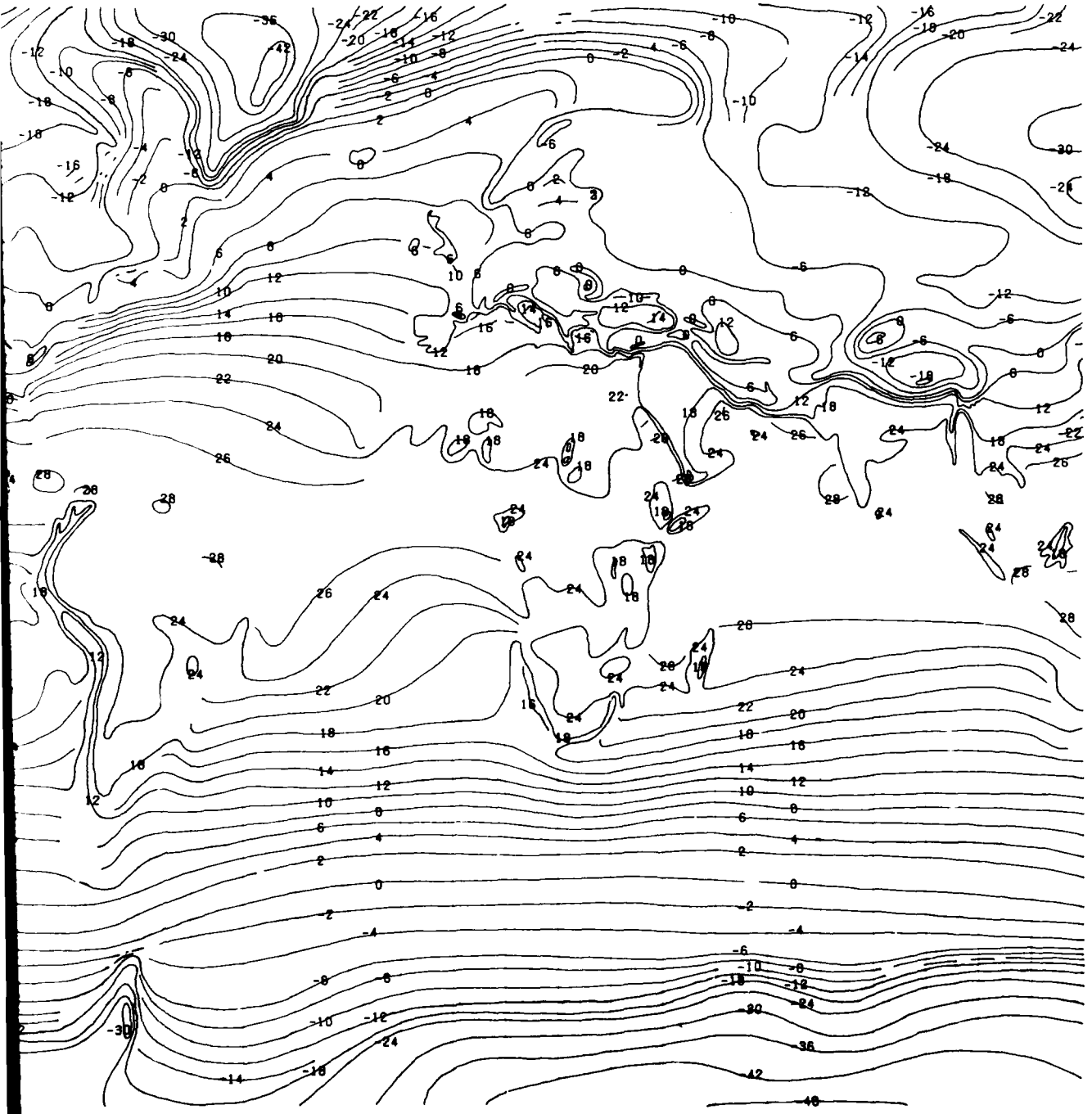
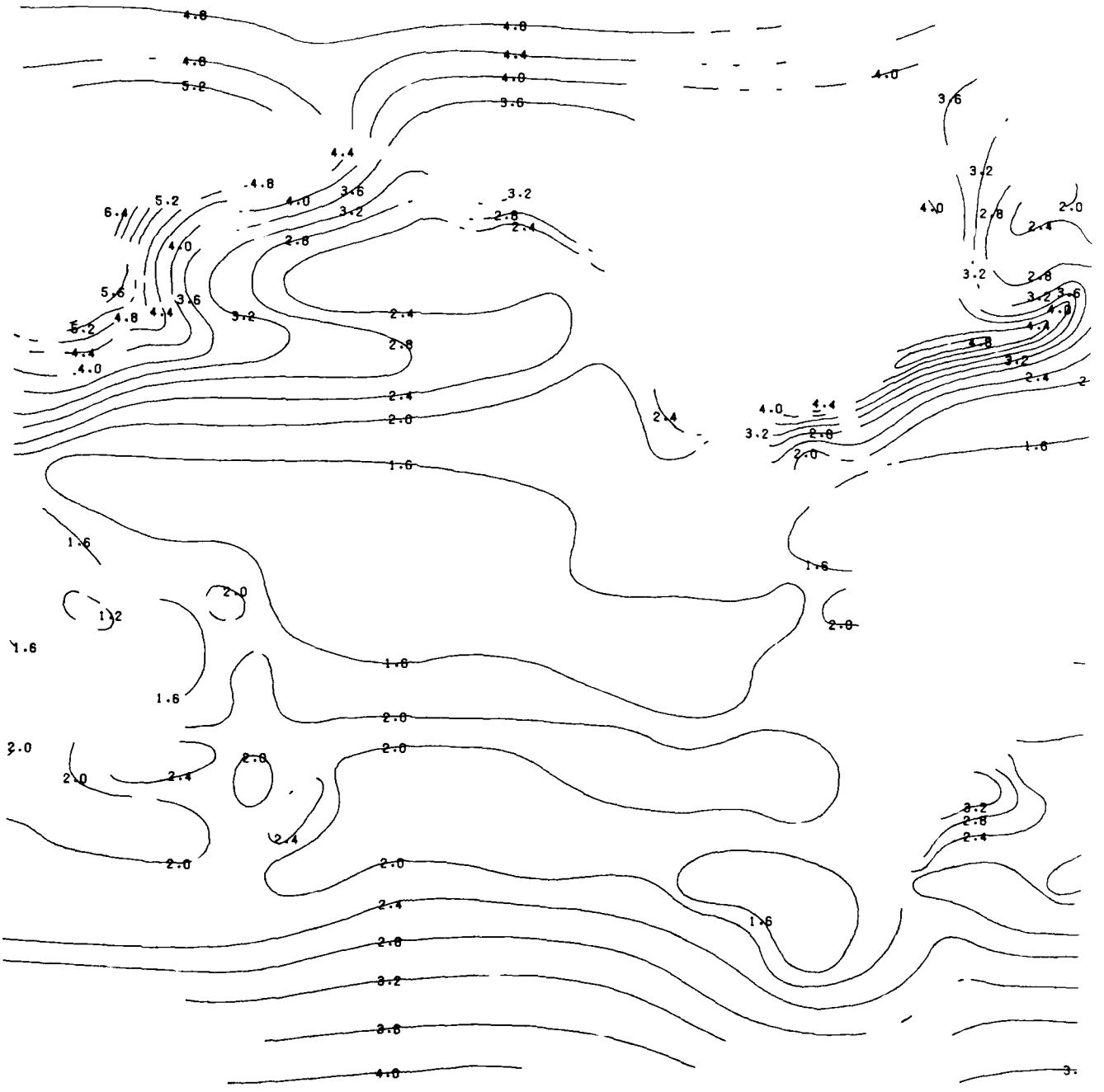


SURFACE AIR TEMPERATURE (°C) - MEANS



SURFACE AIR TEMPERATURE (°C) - STANDARD DEVIATIONS



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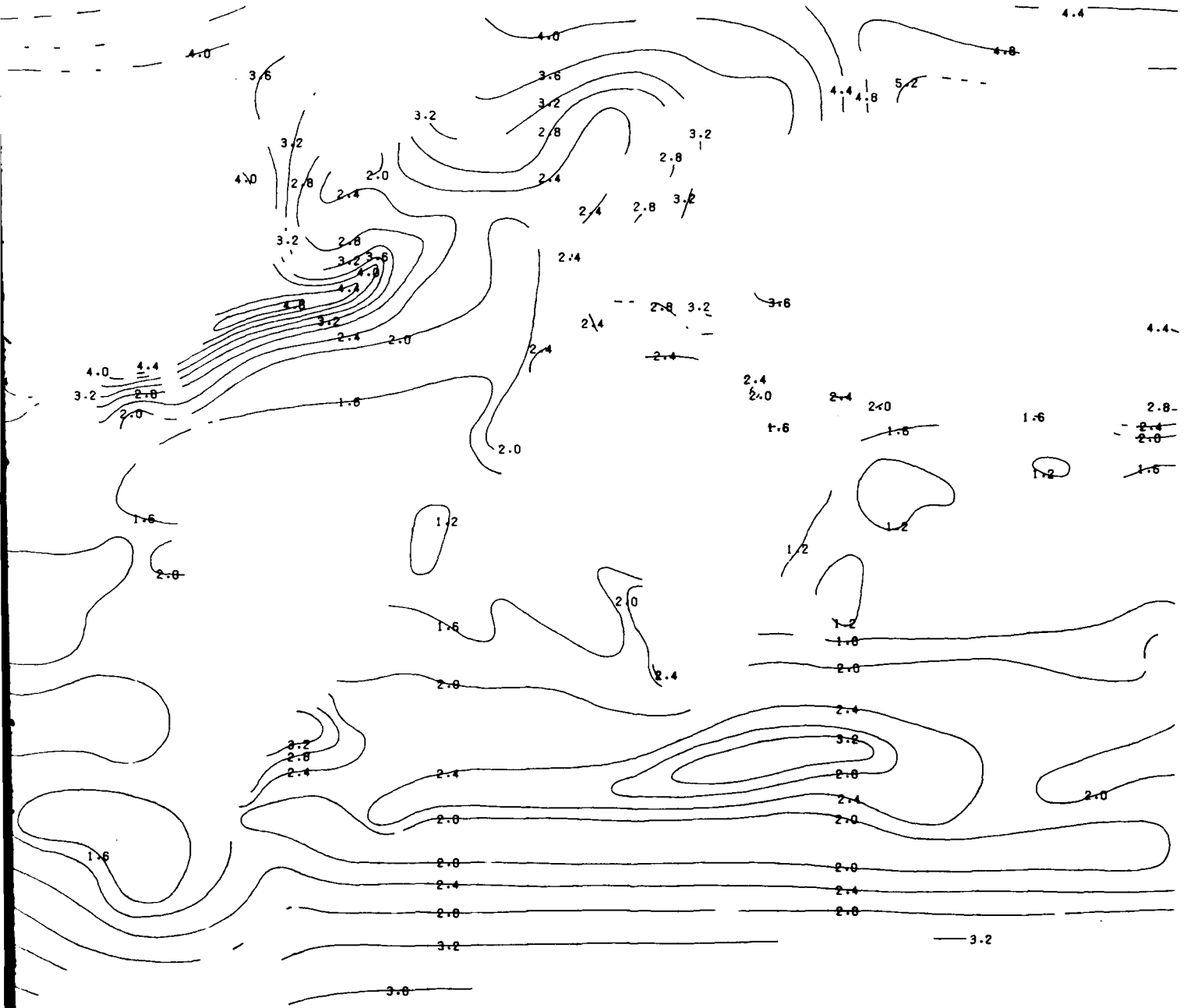

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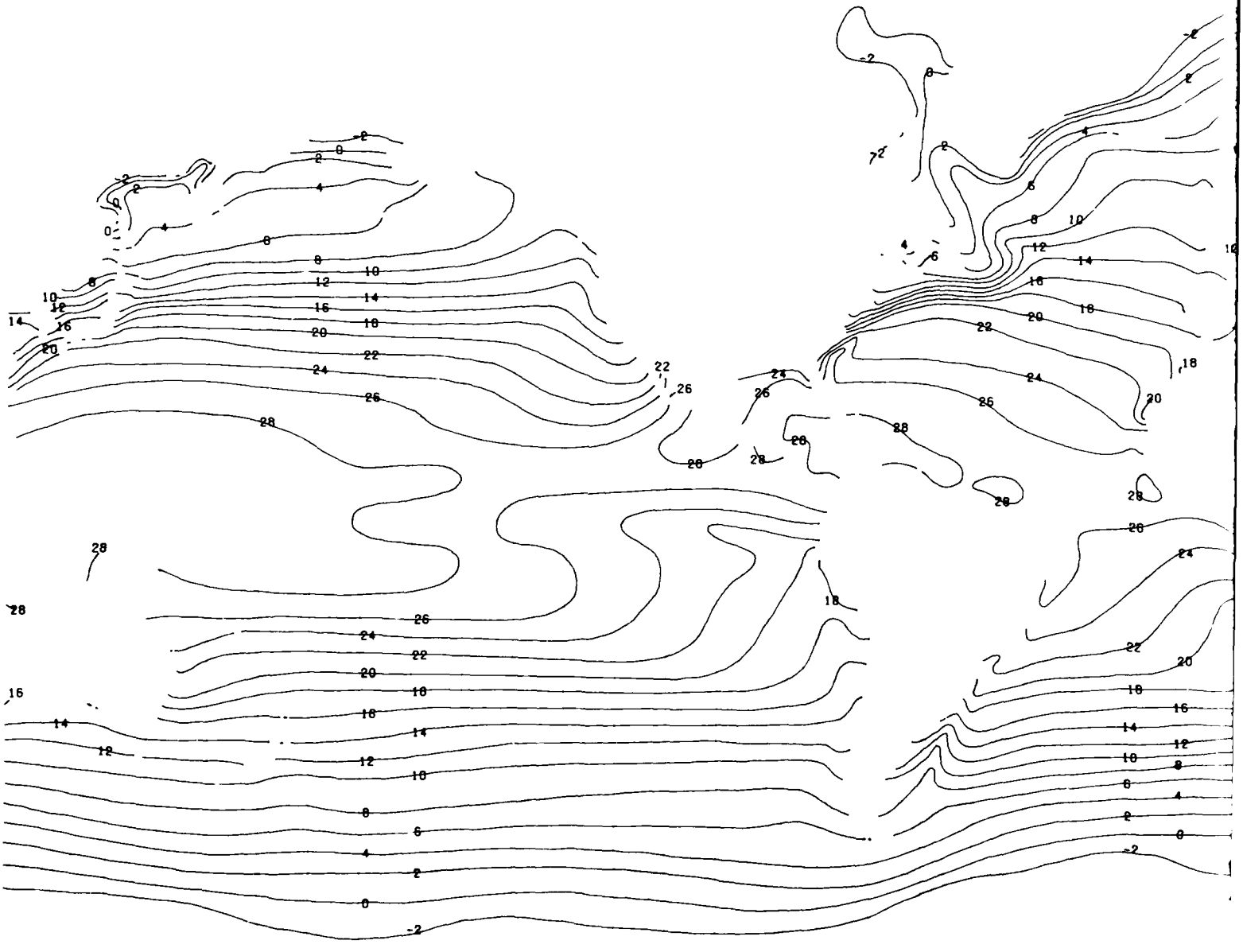
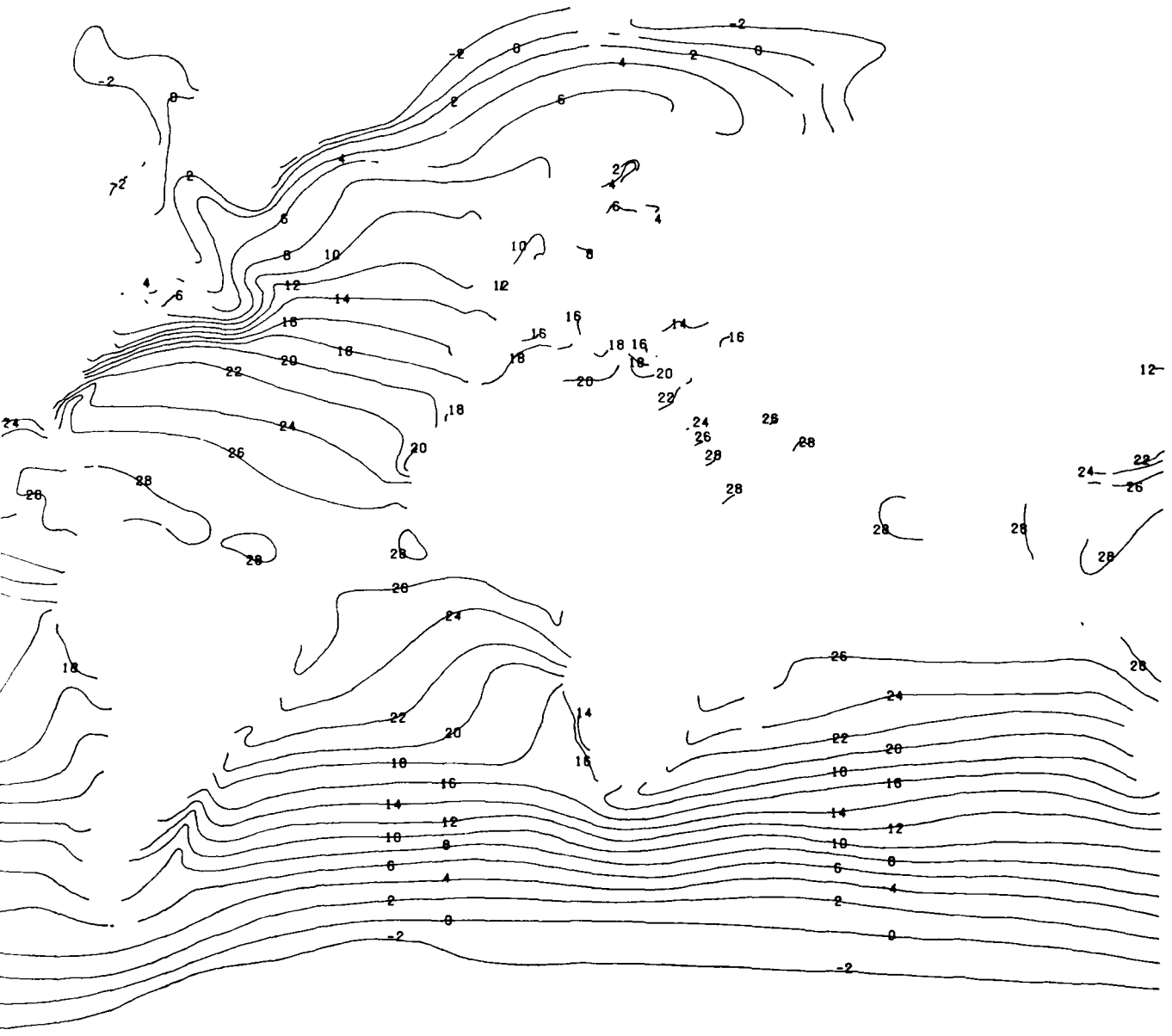
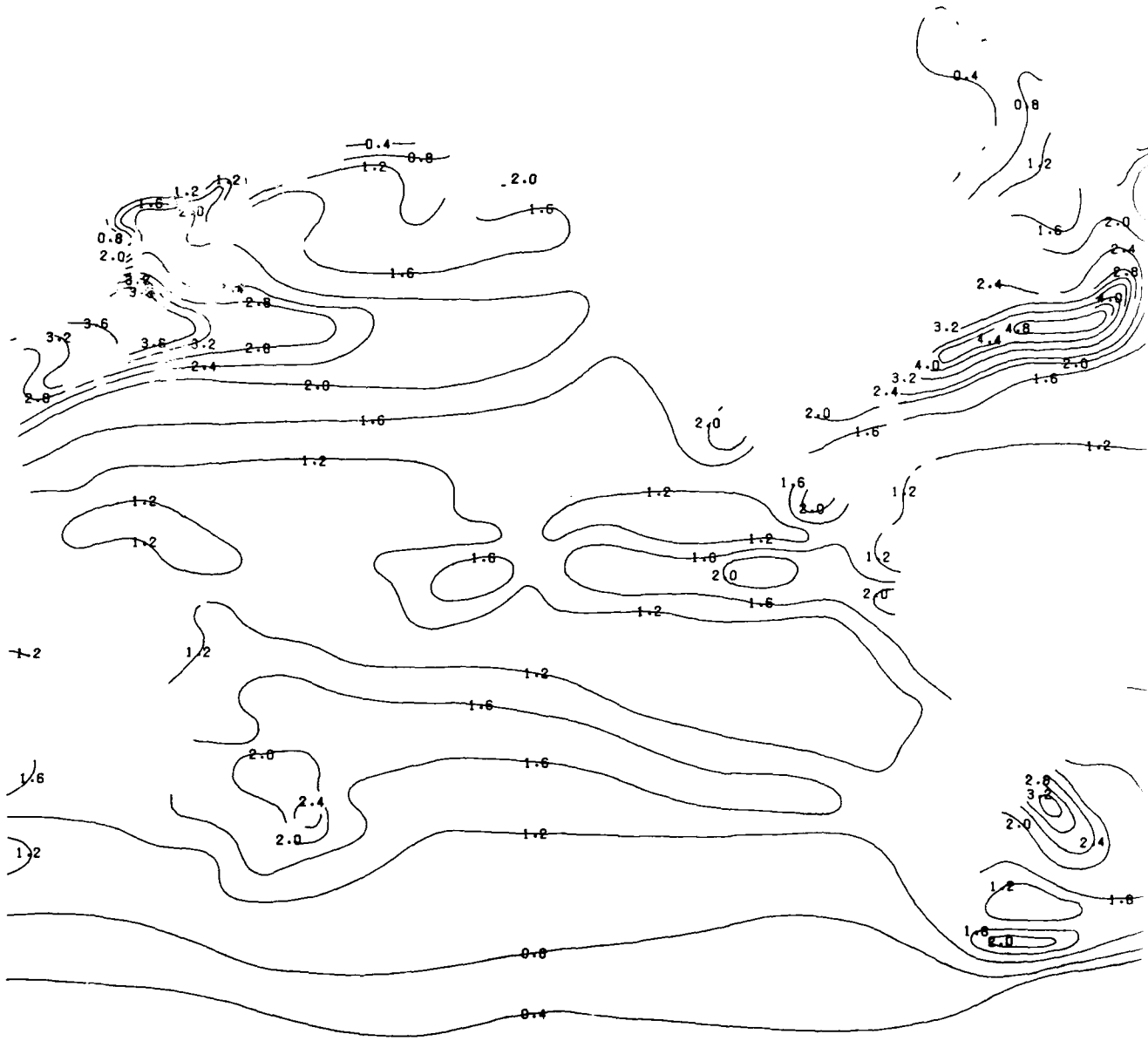


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



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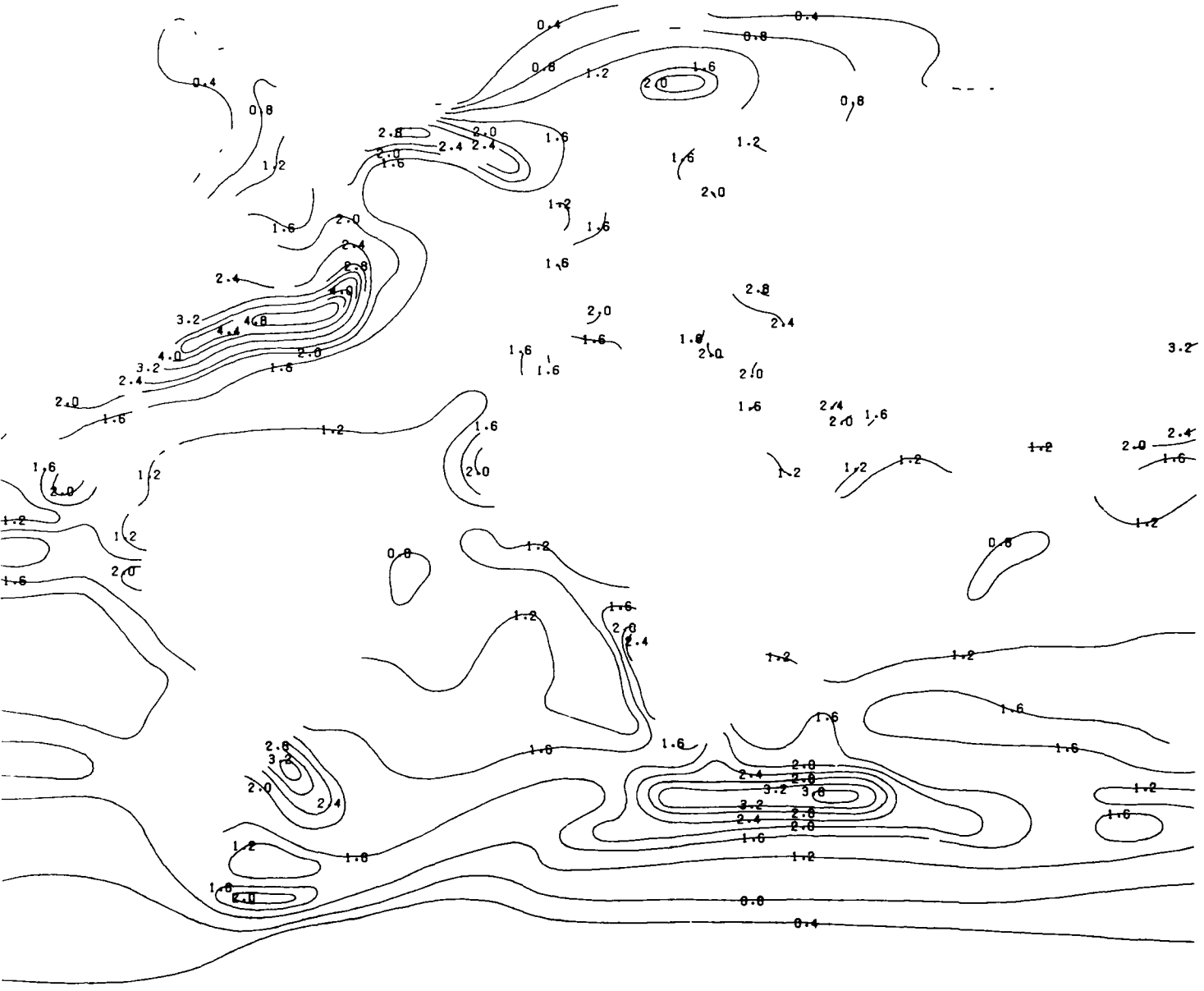

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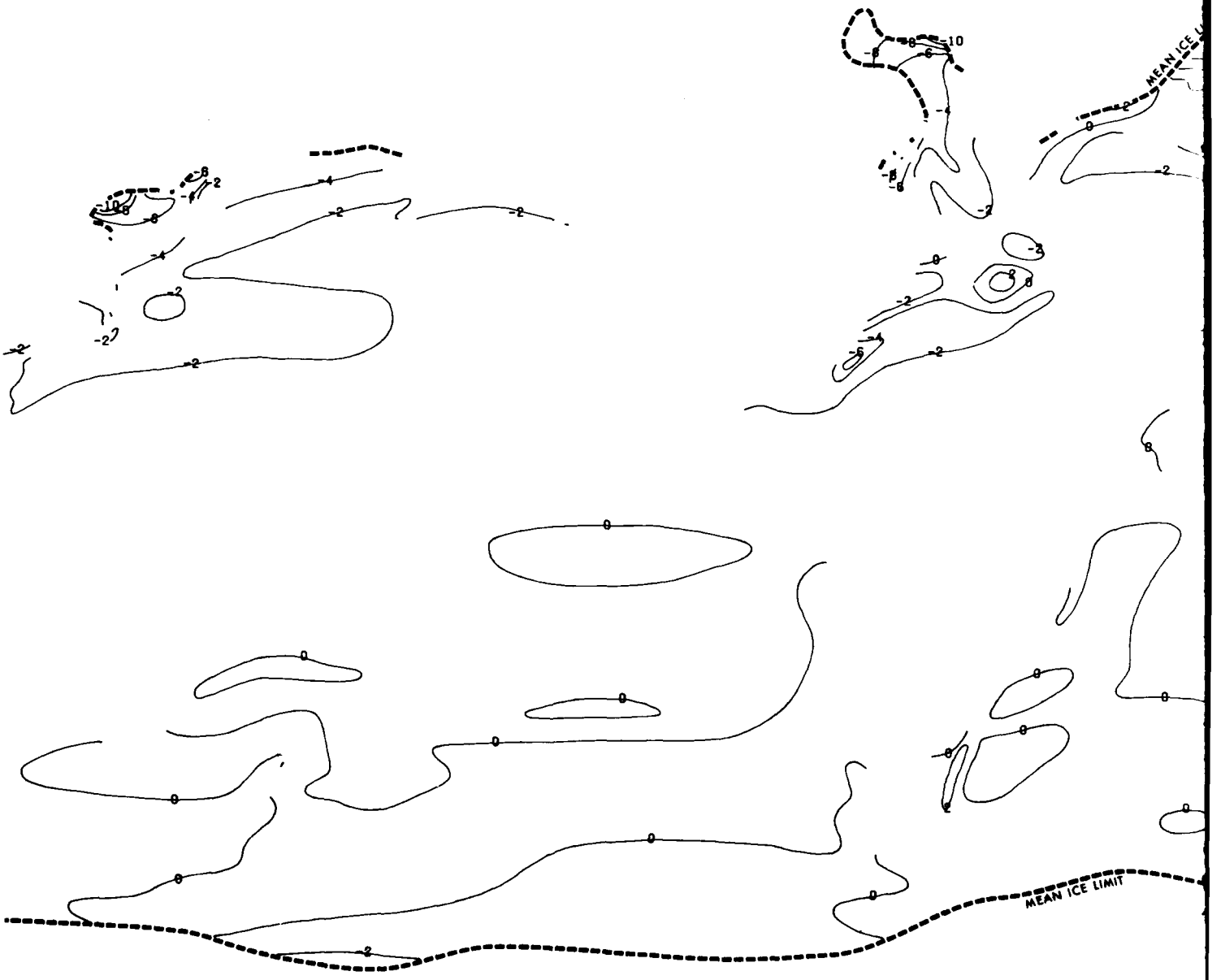
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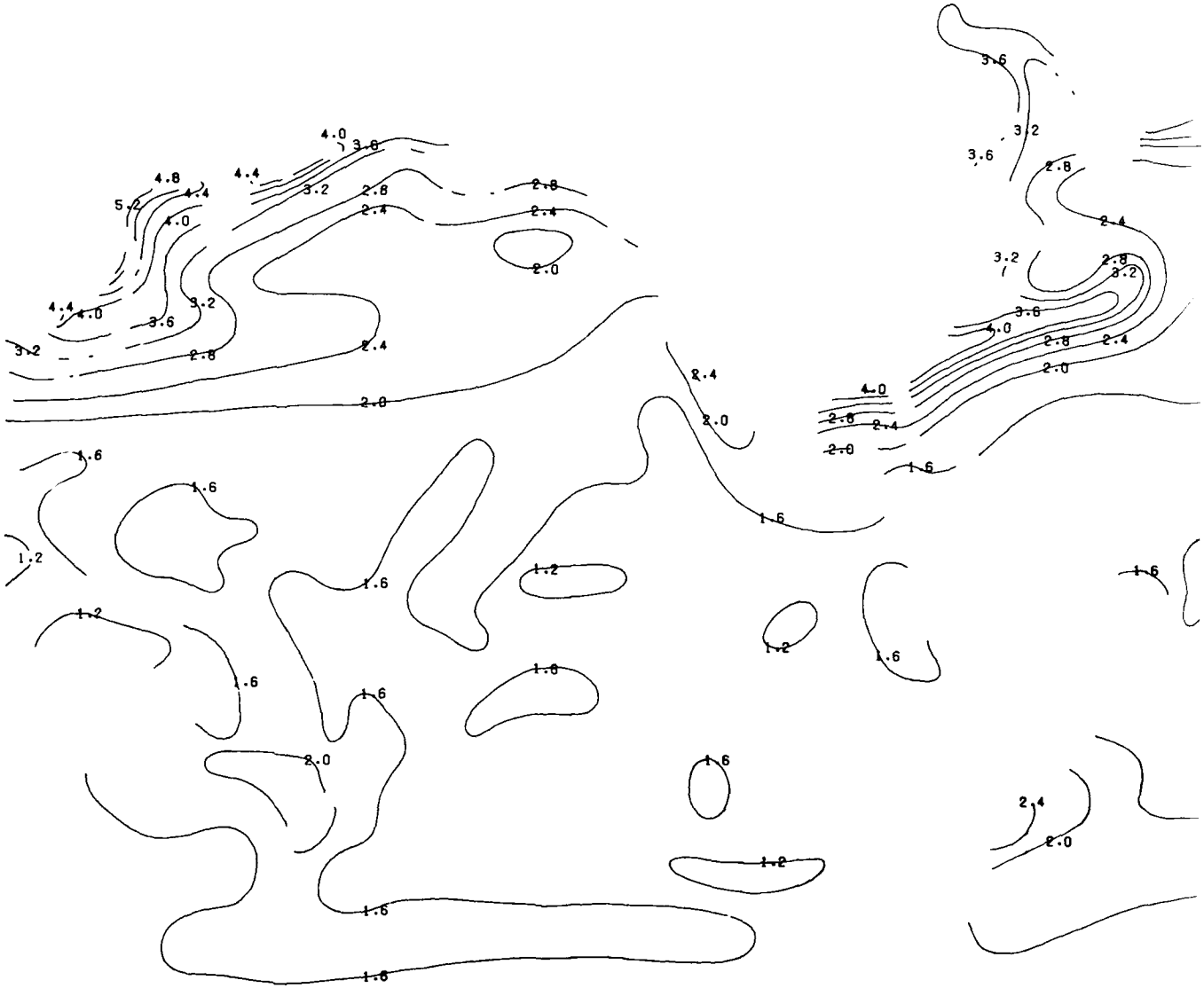
MEAN ICE LIMIT

AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIONS



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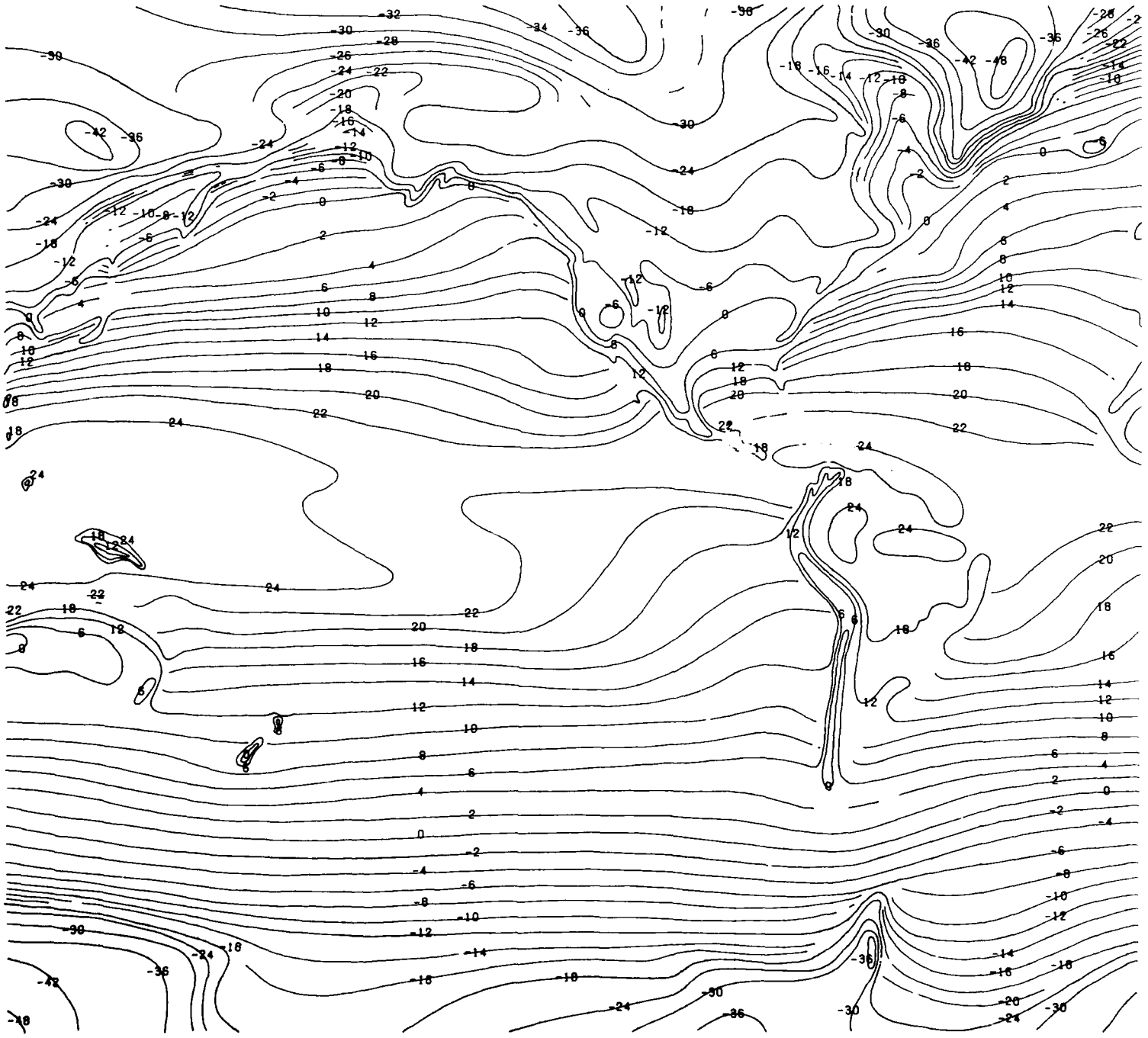
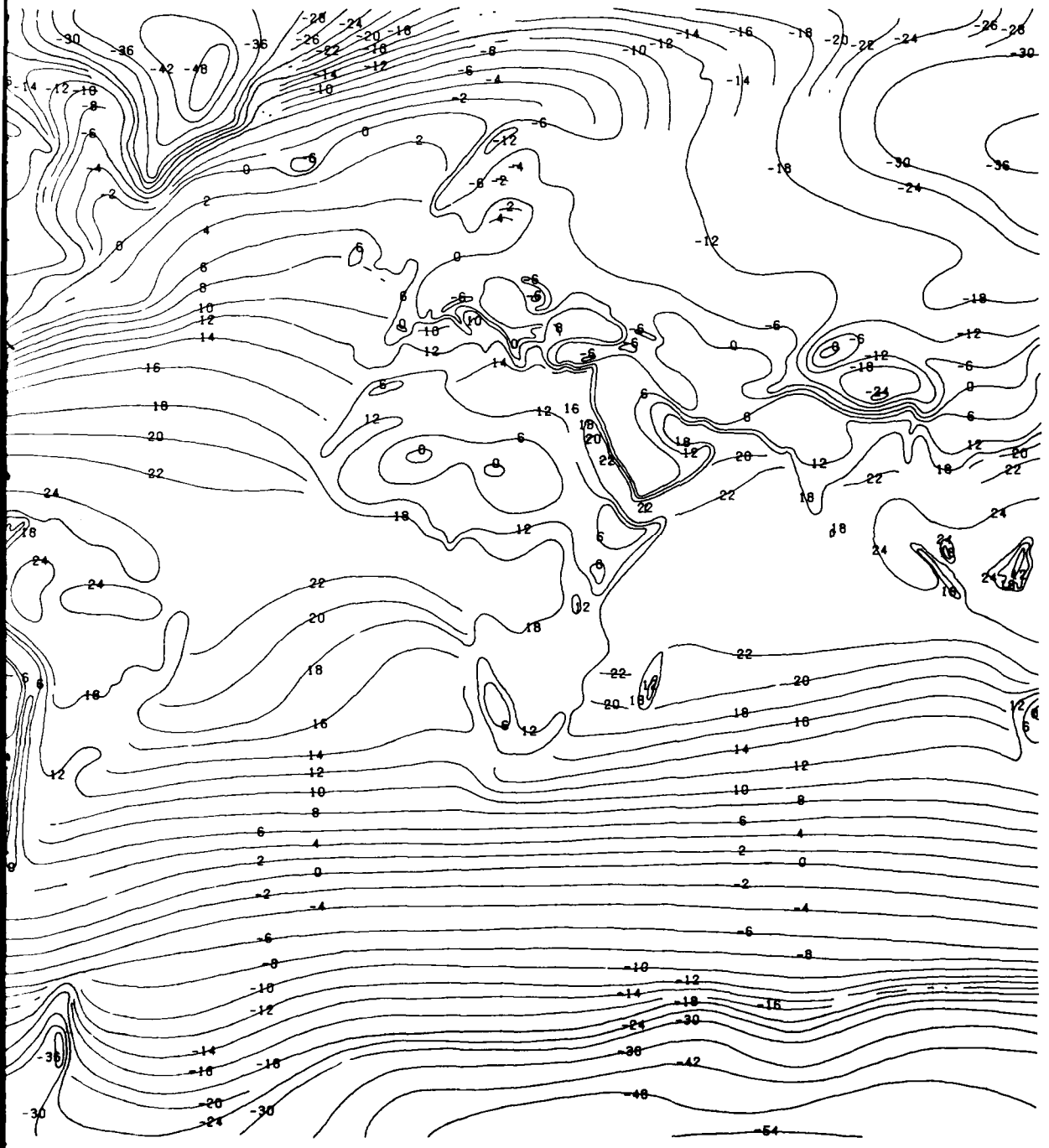
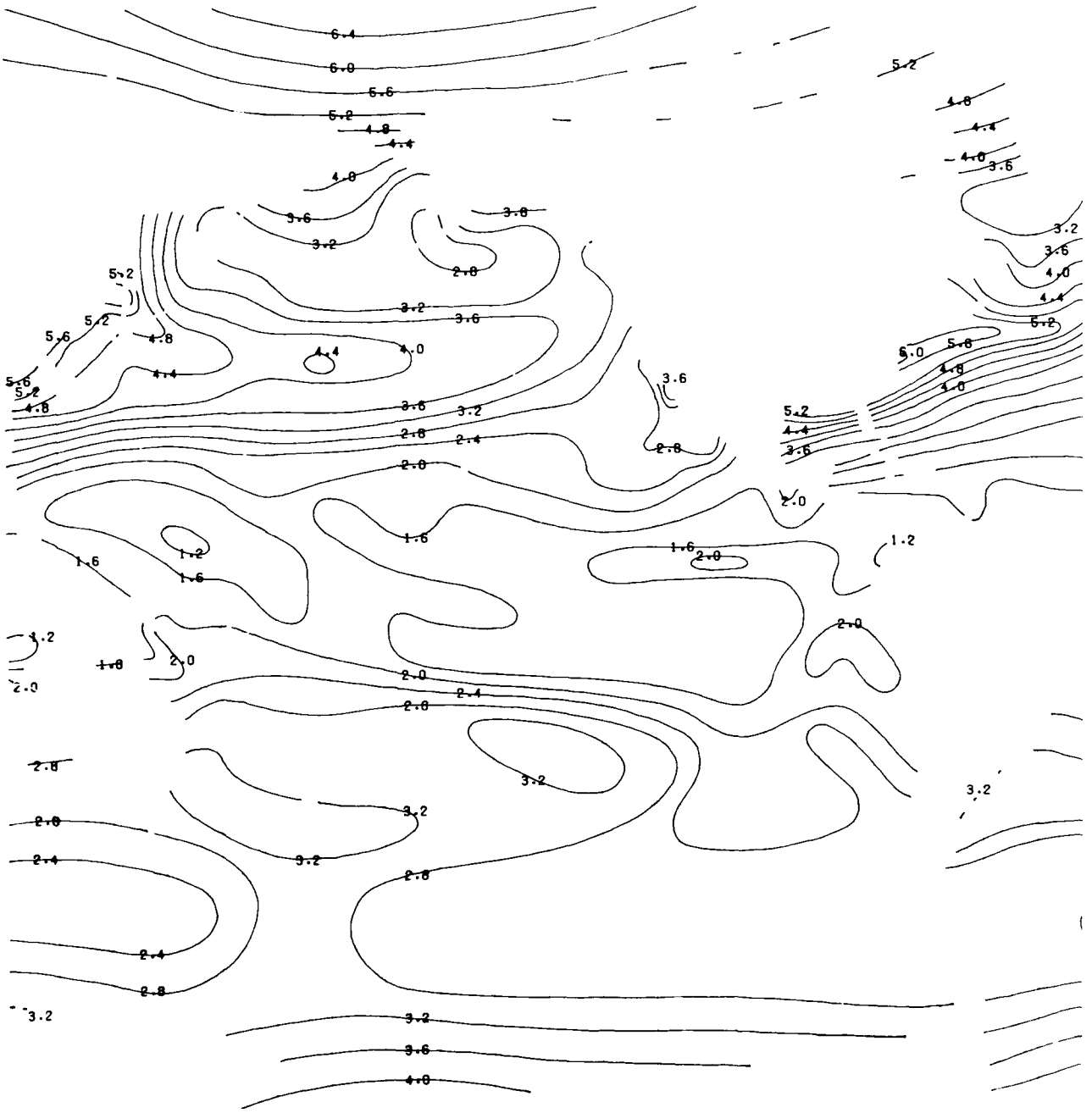


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



ARD DEVIATIONS

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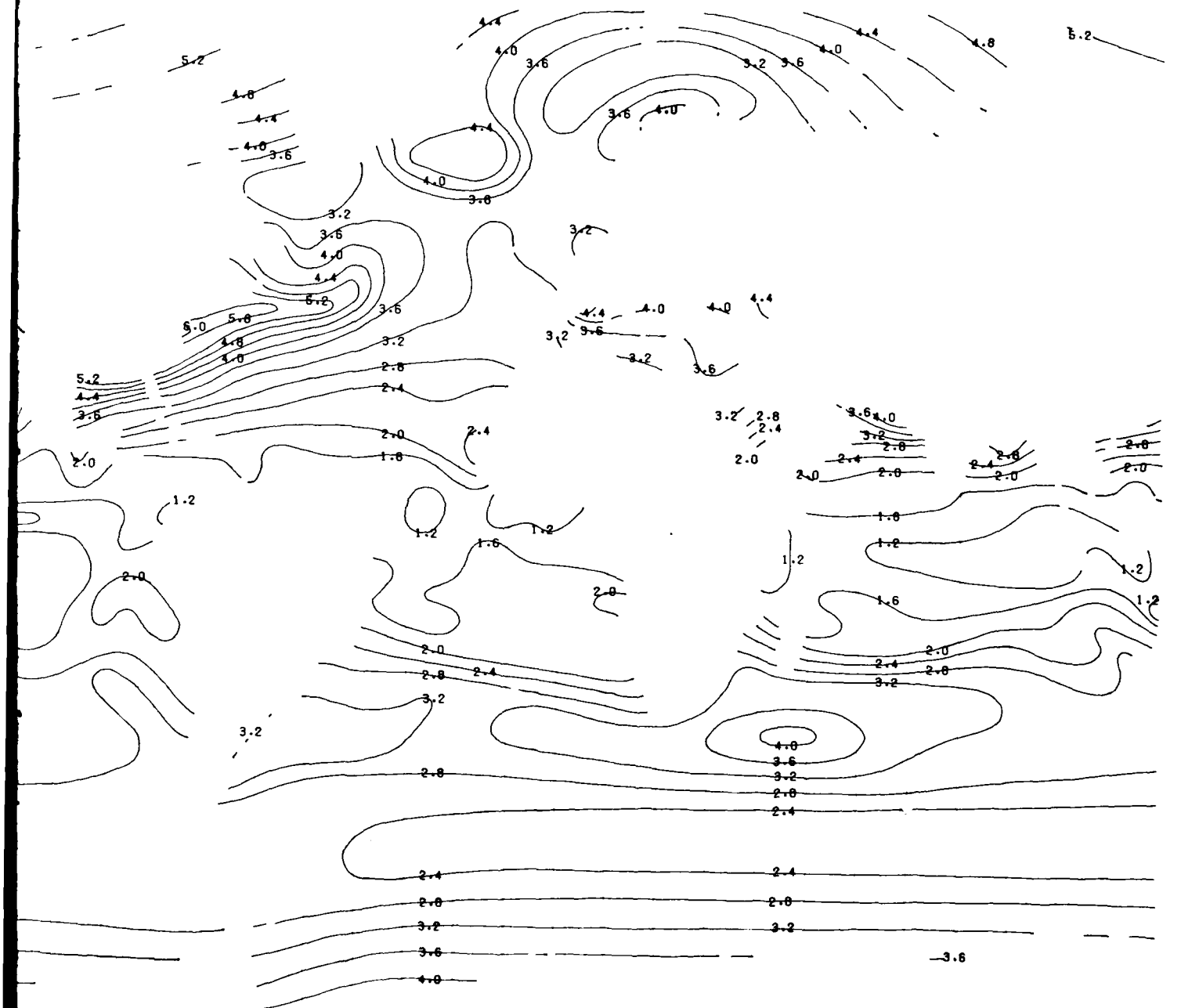

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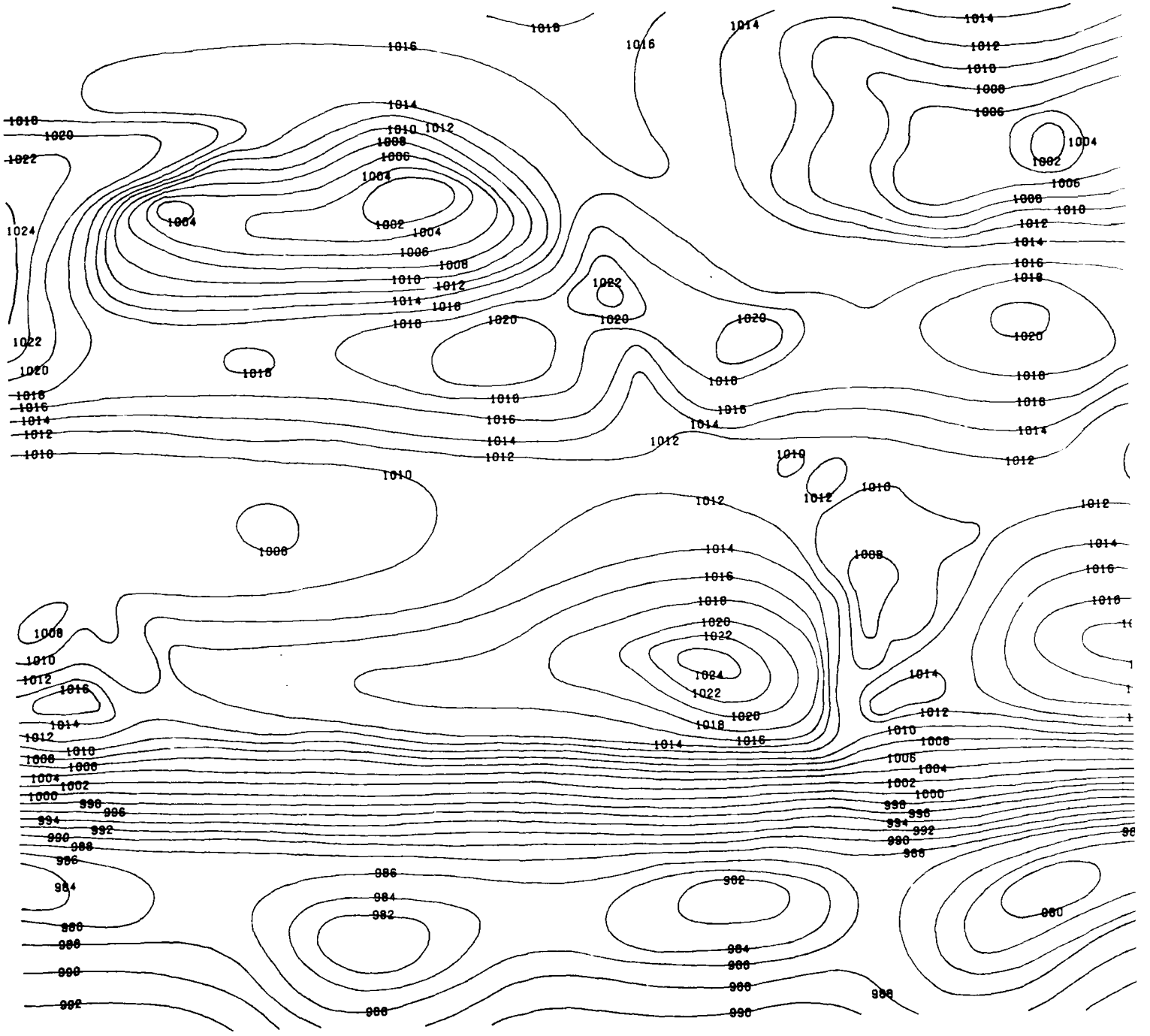
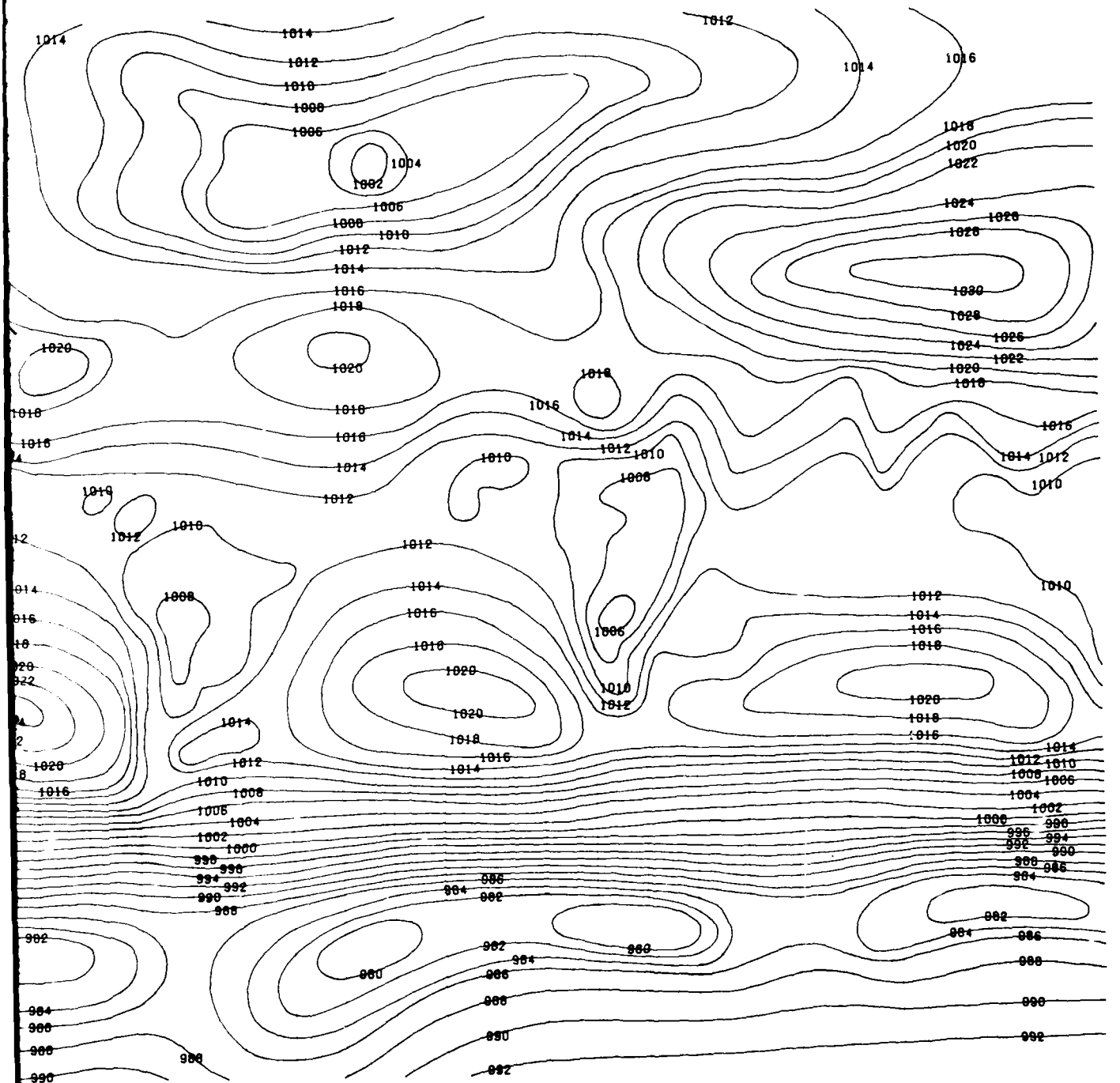
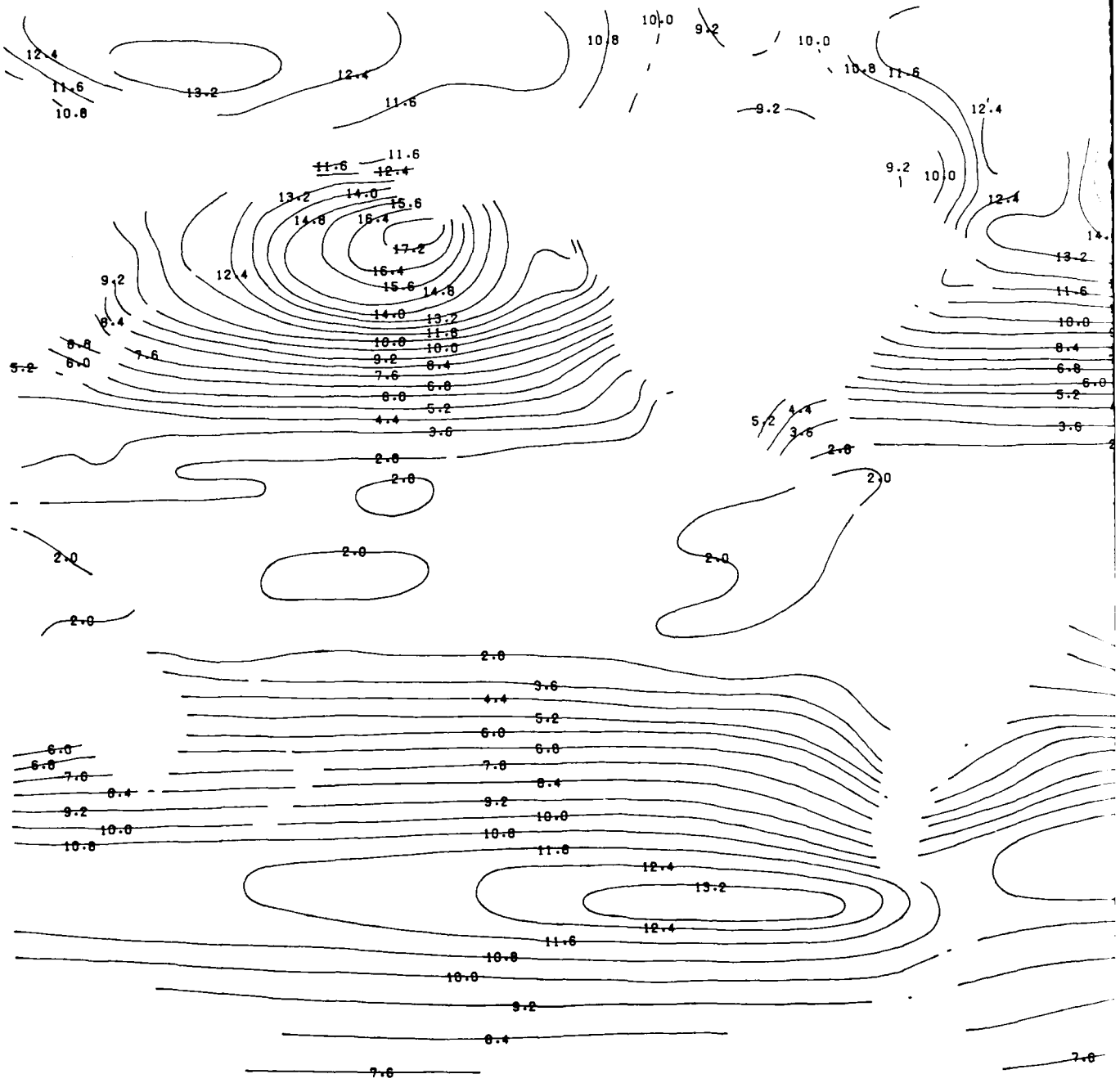


SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



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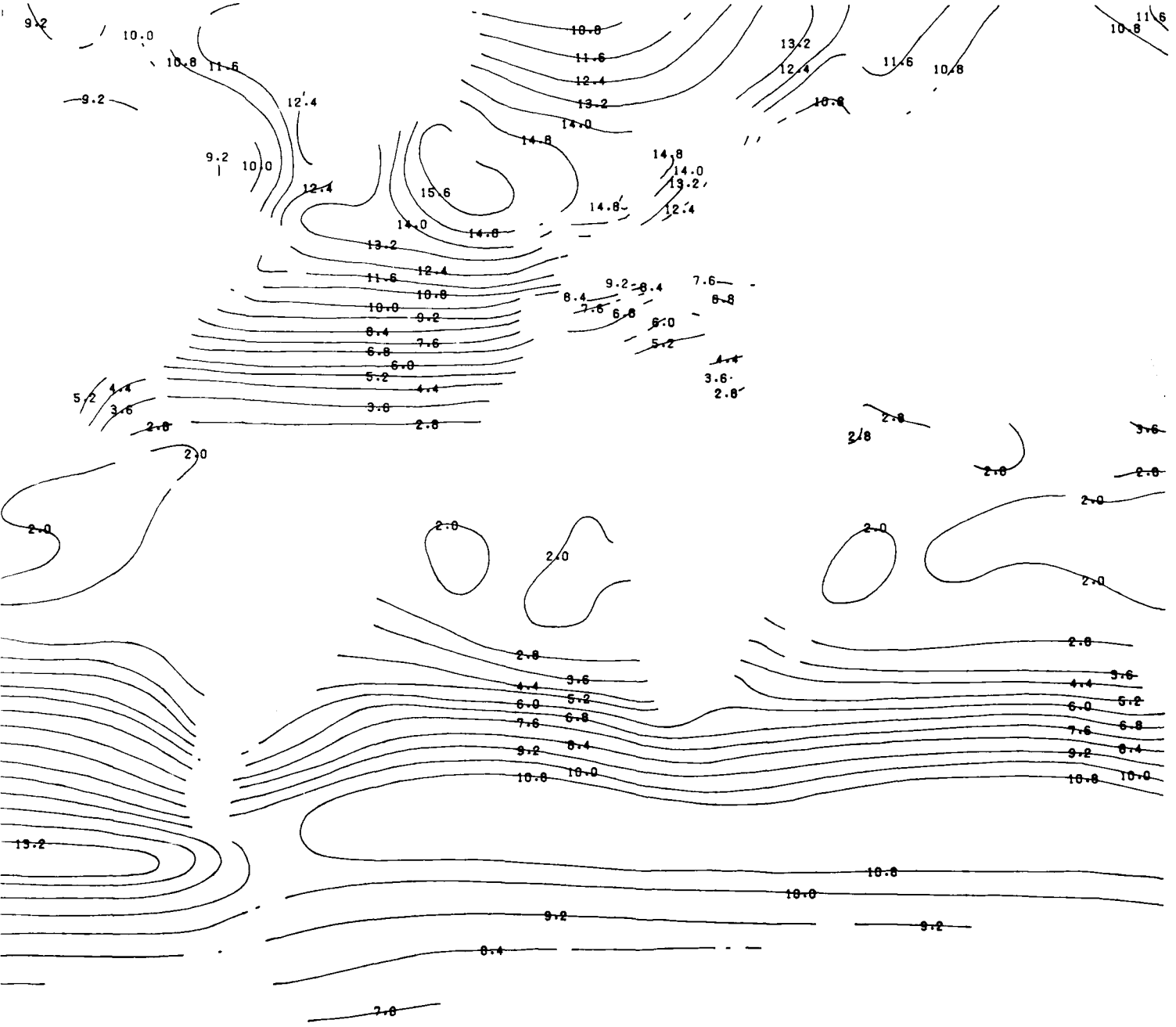

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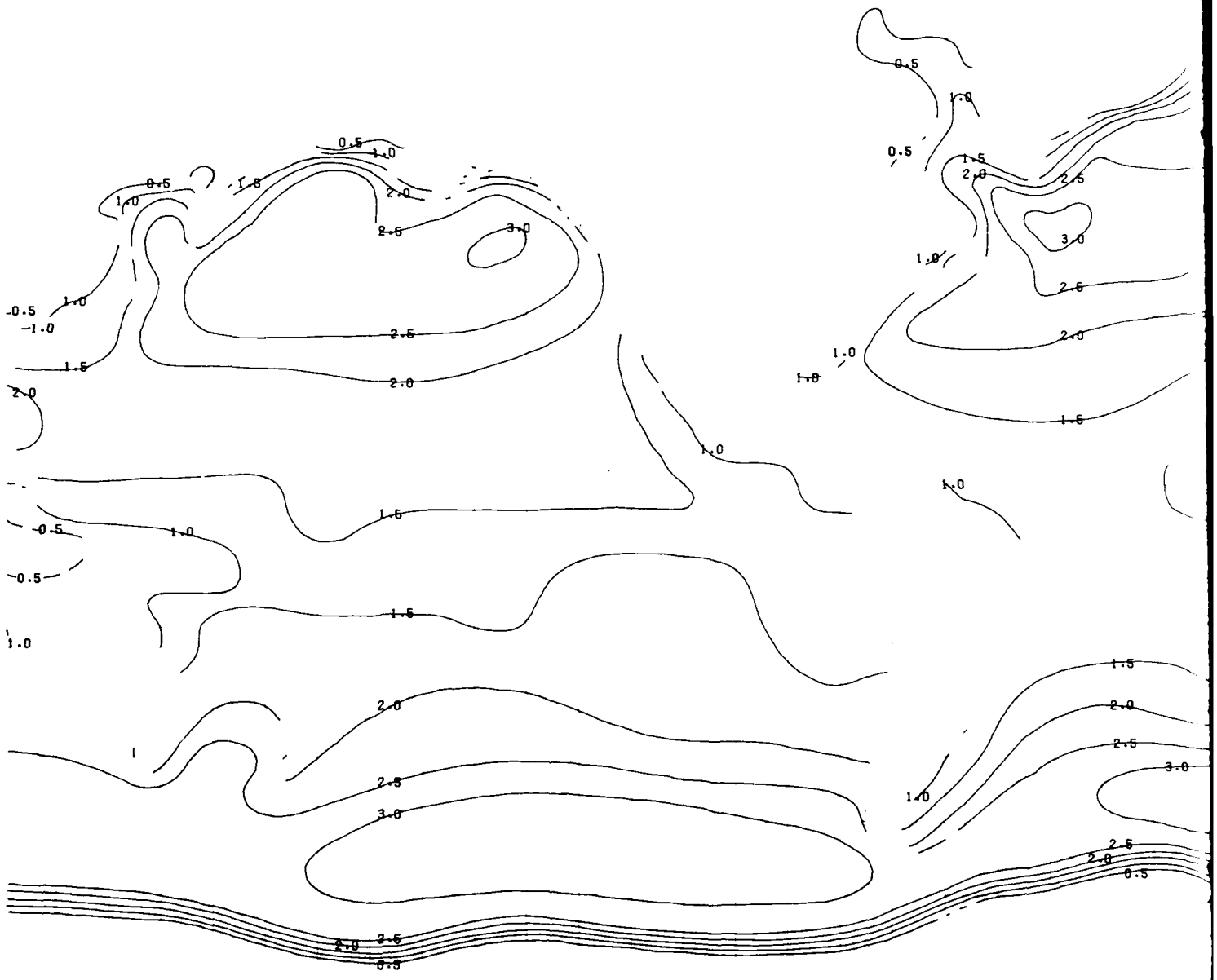
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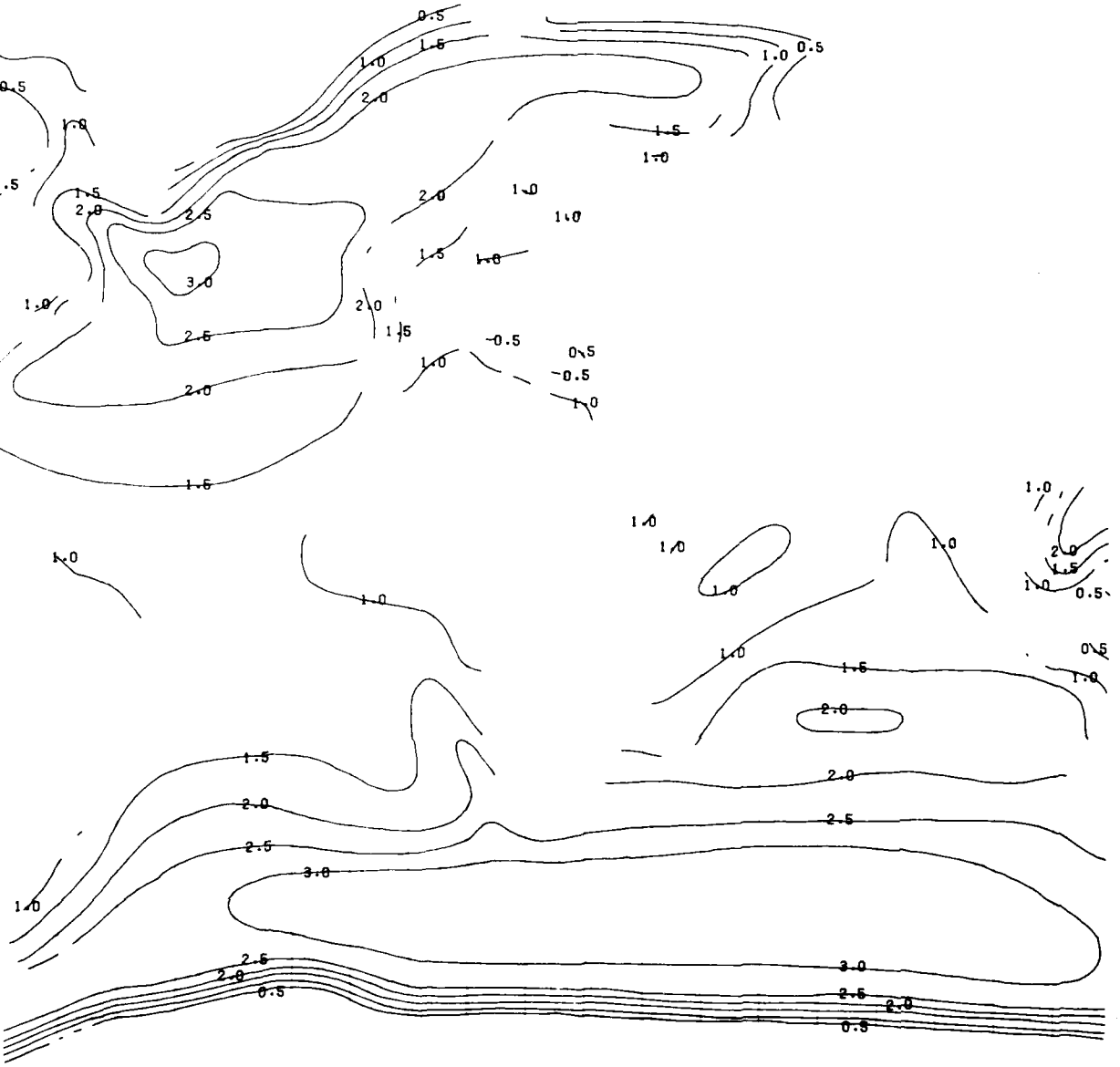
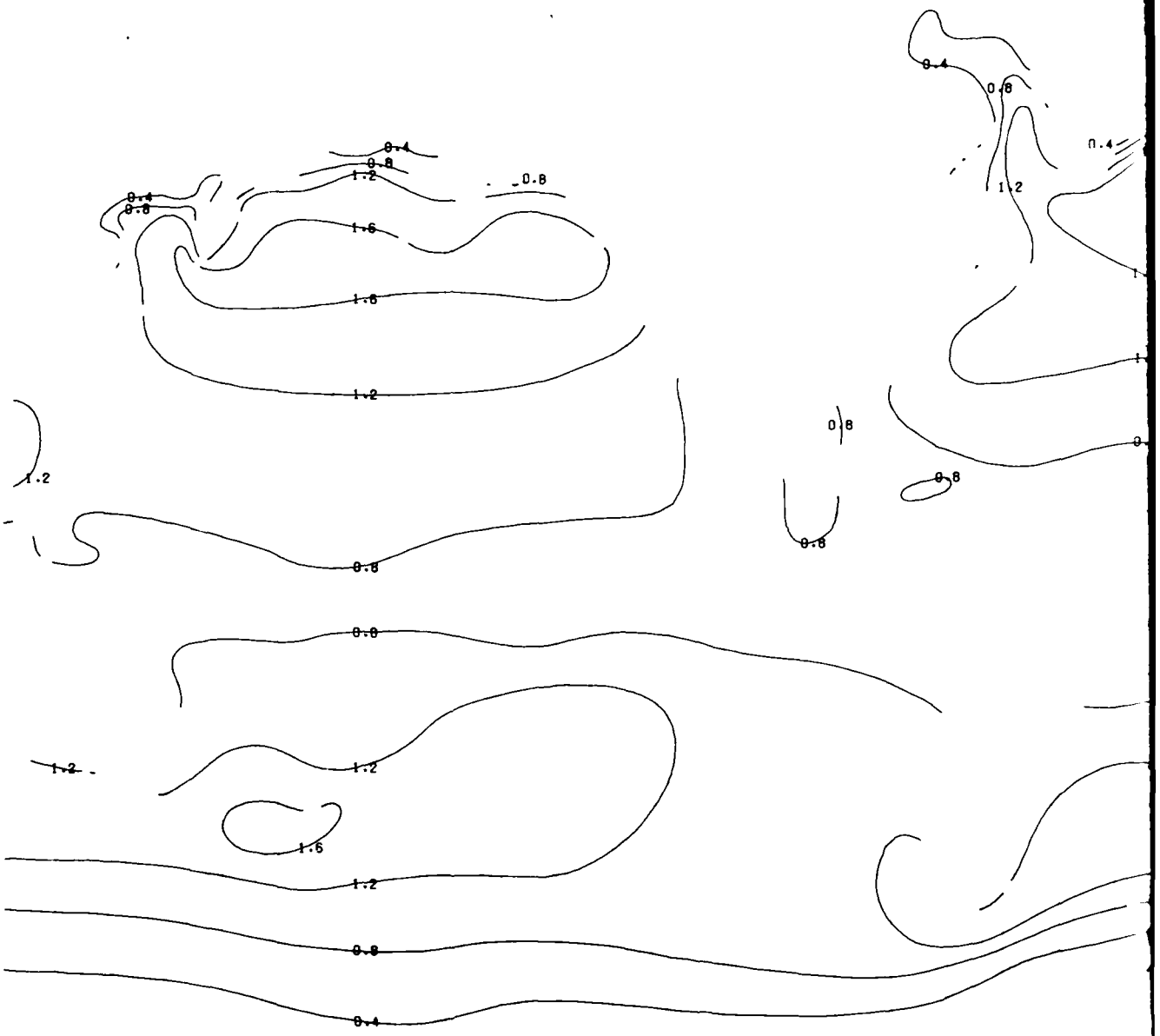
WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS



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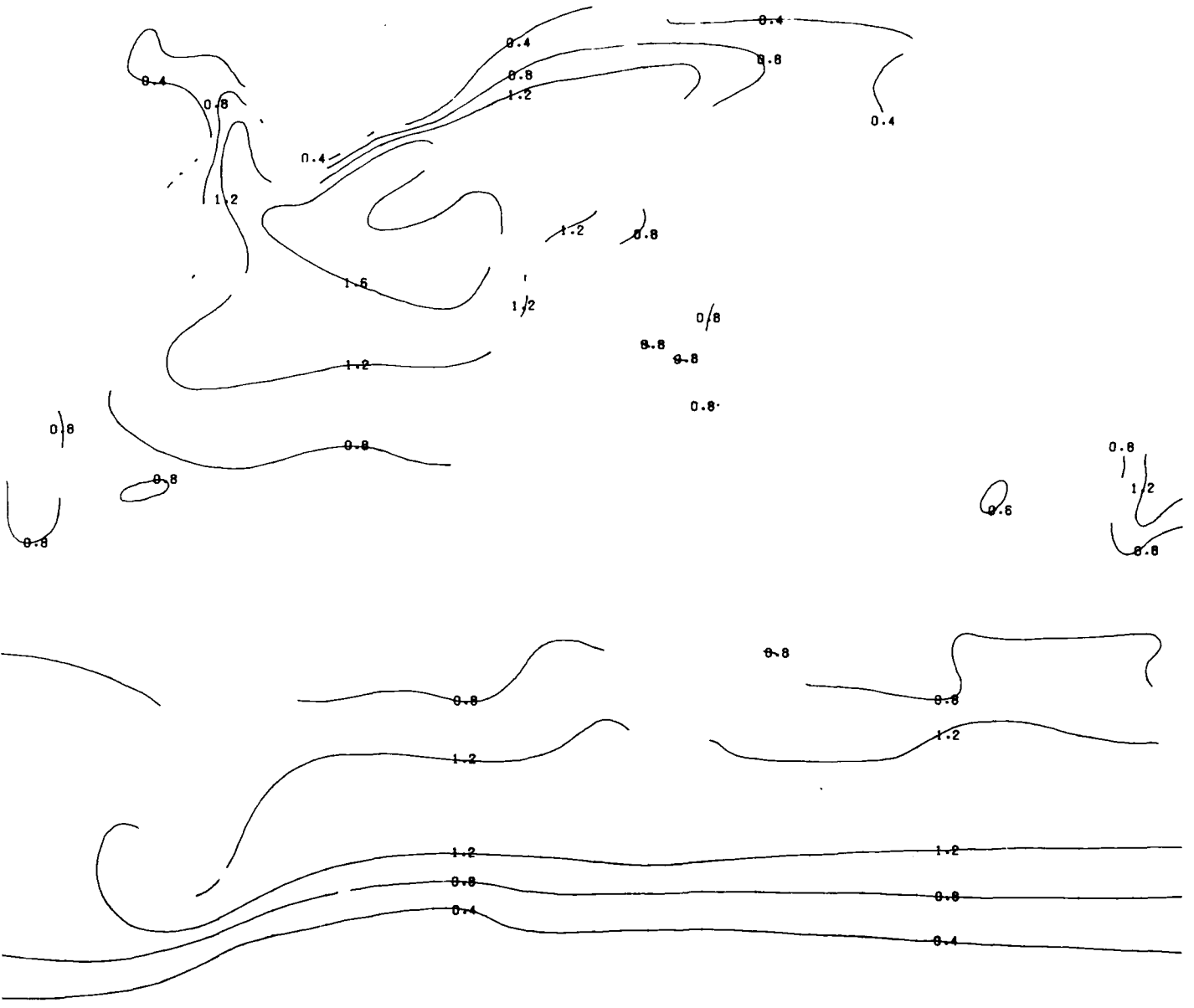

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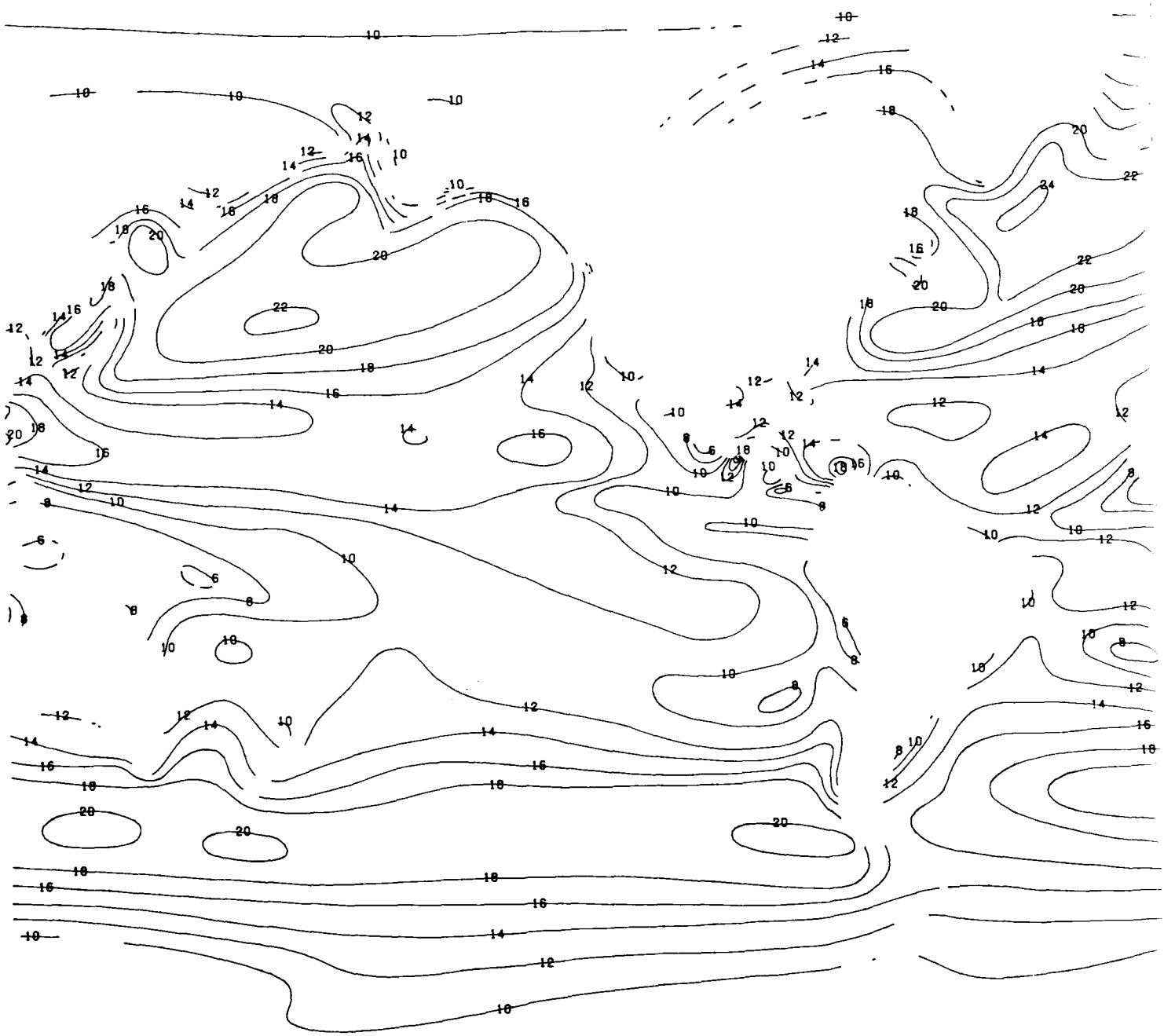
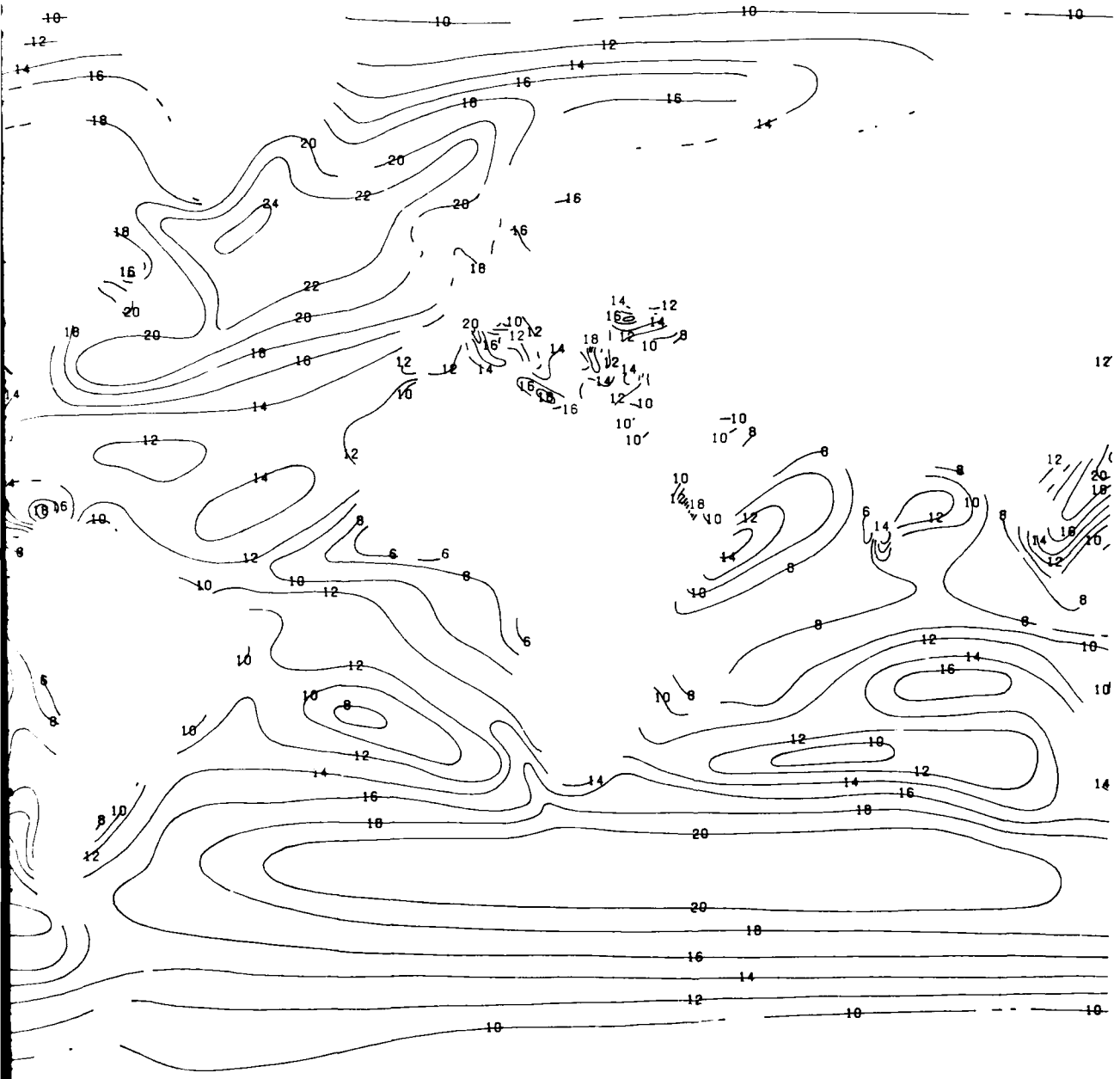
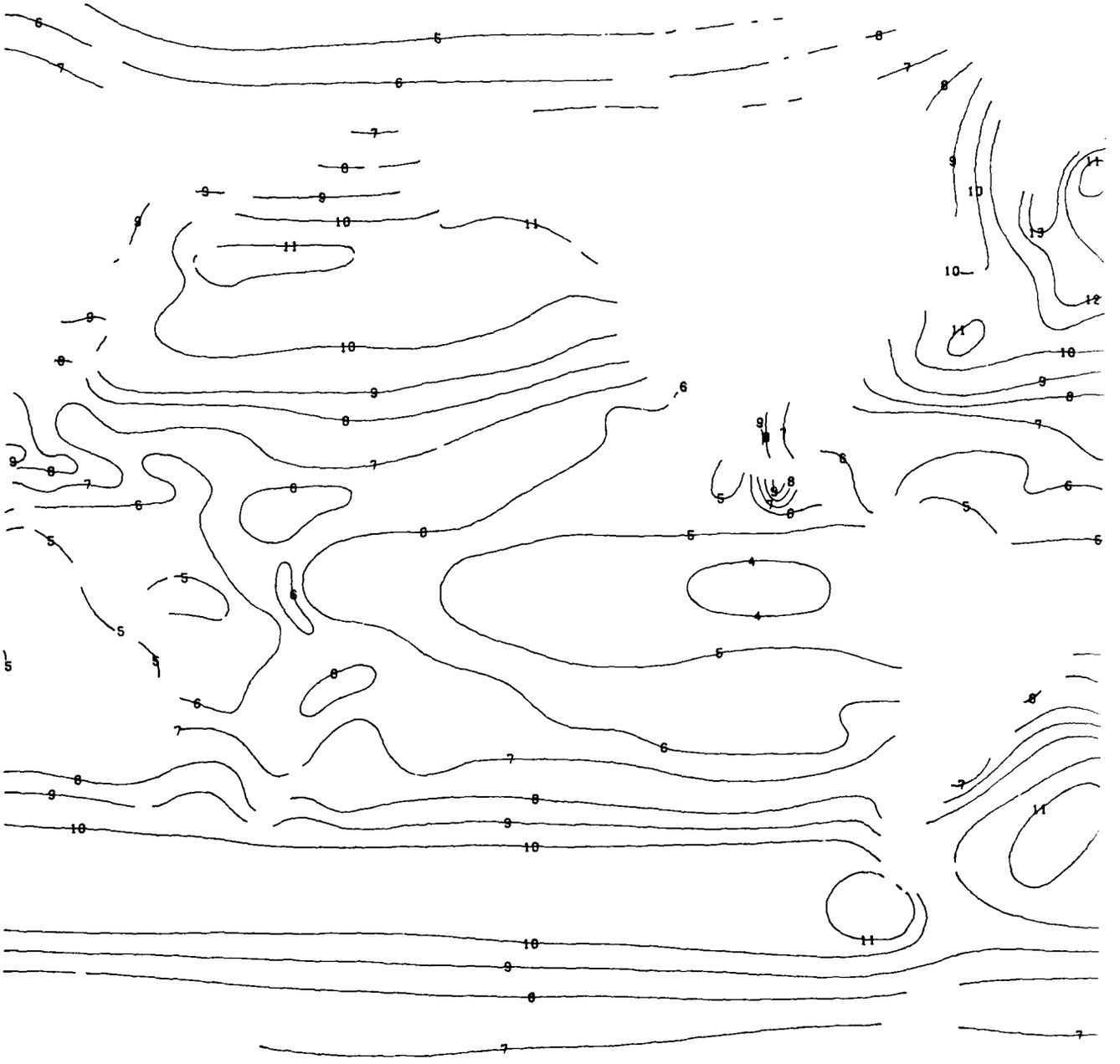


SURFACE WINDS (KTS) - MEANS



SURFACE WINDS (KTS) - STANDARD DEVIATIONS



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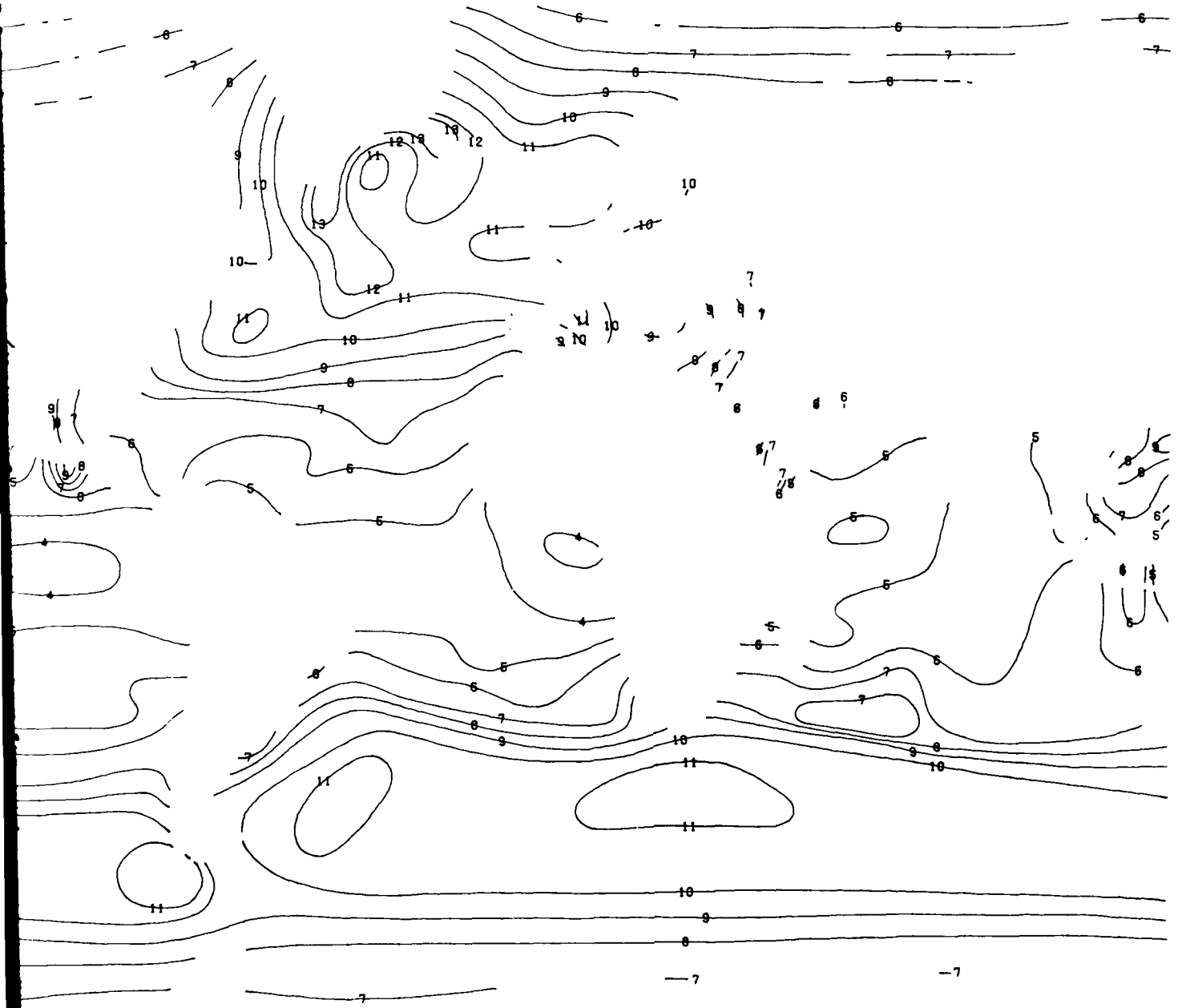

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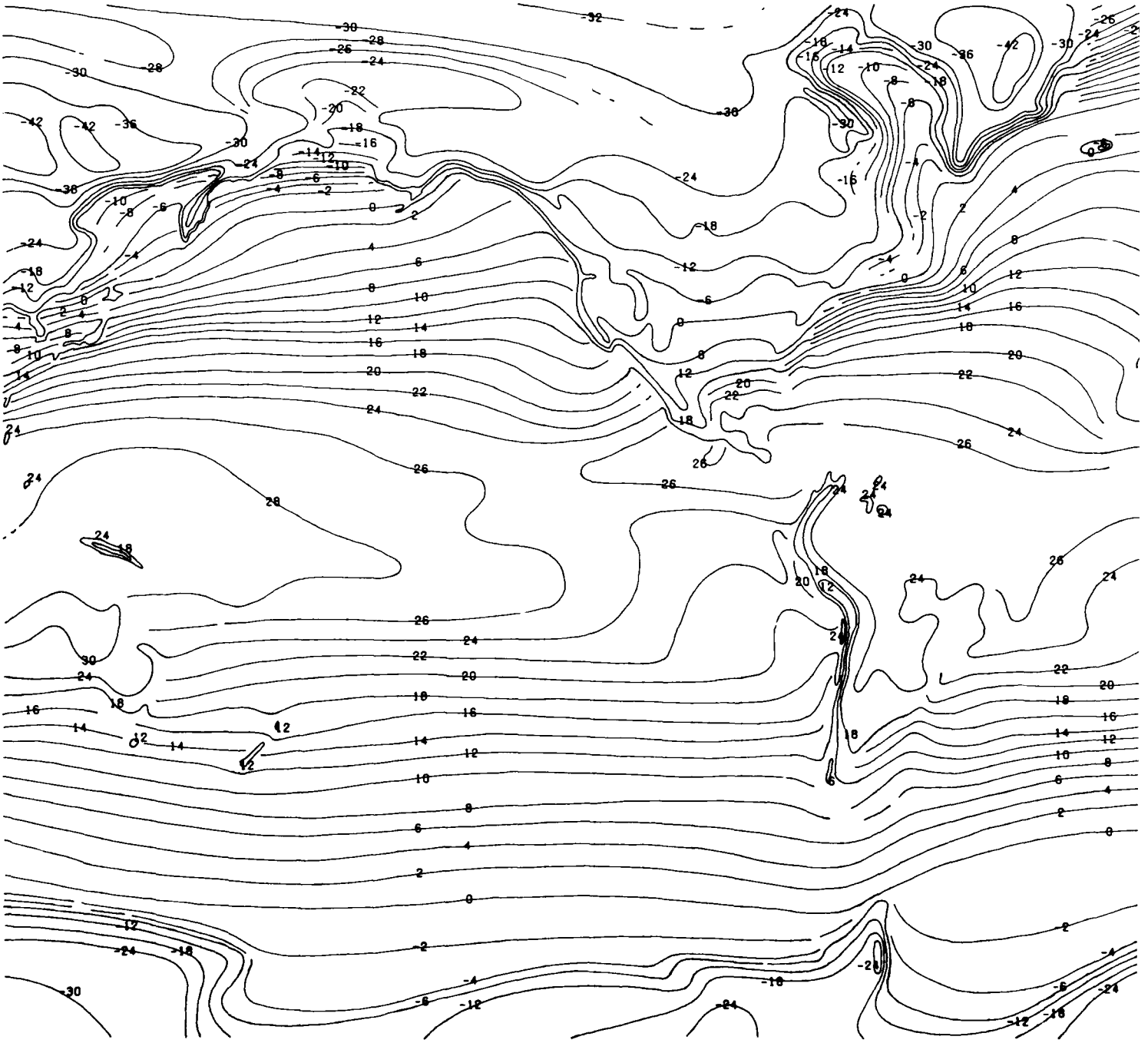
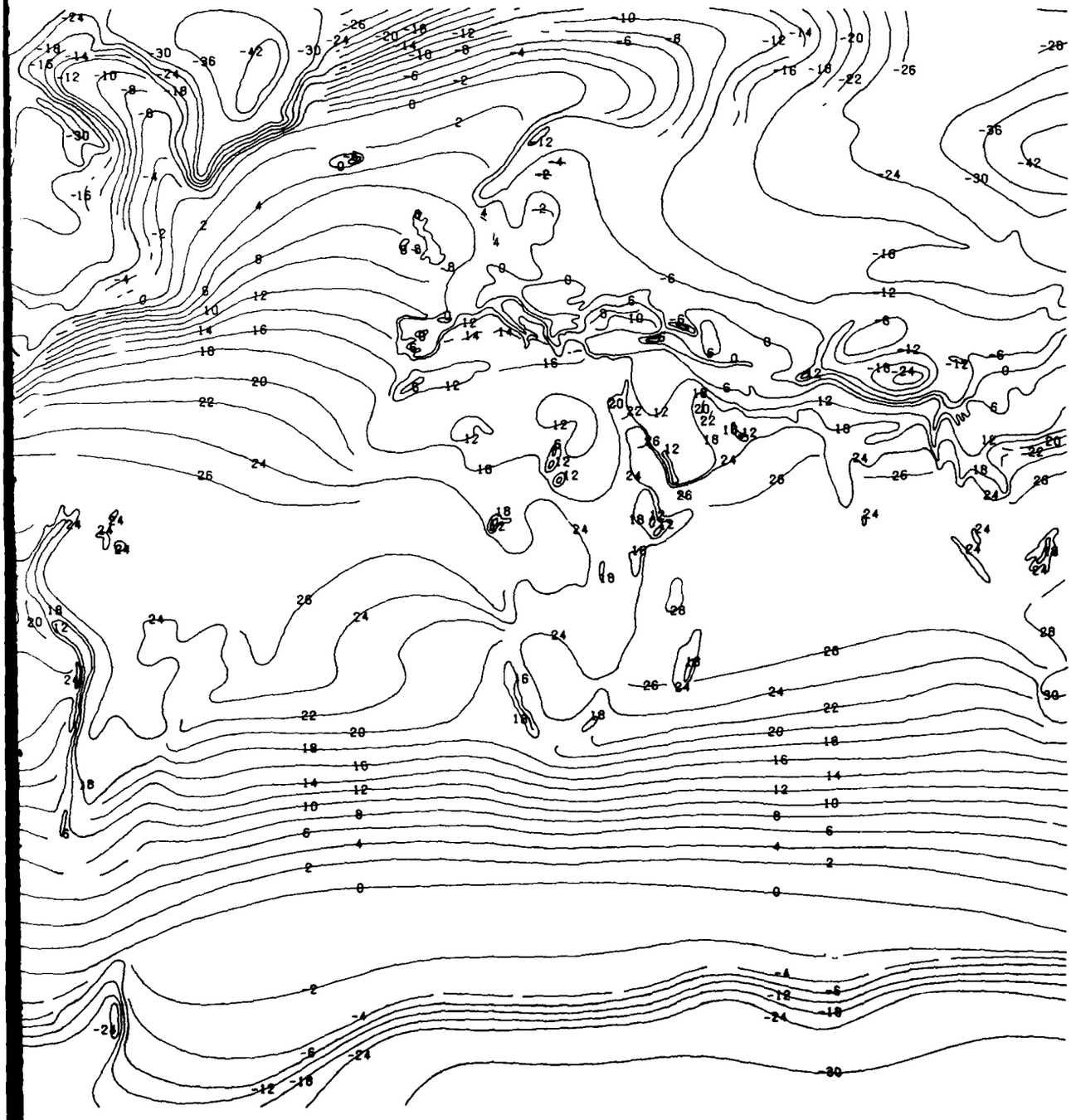


SURFACE AIR TEMPERATURE (°C) - MEANS



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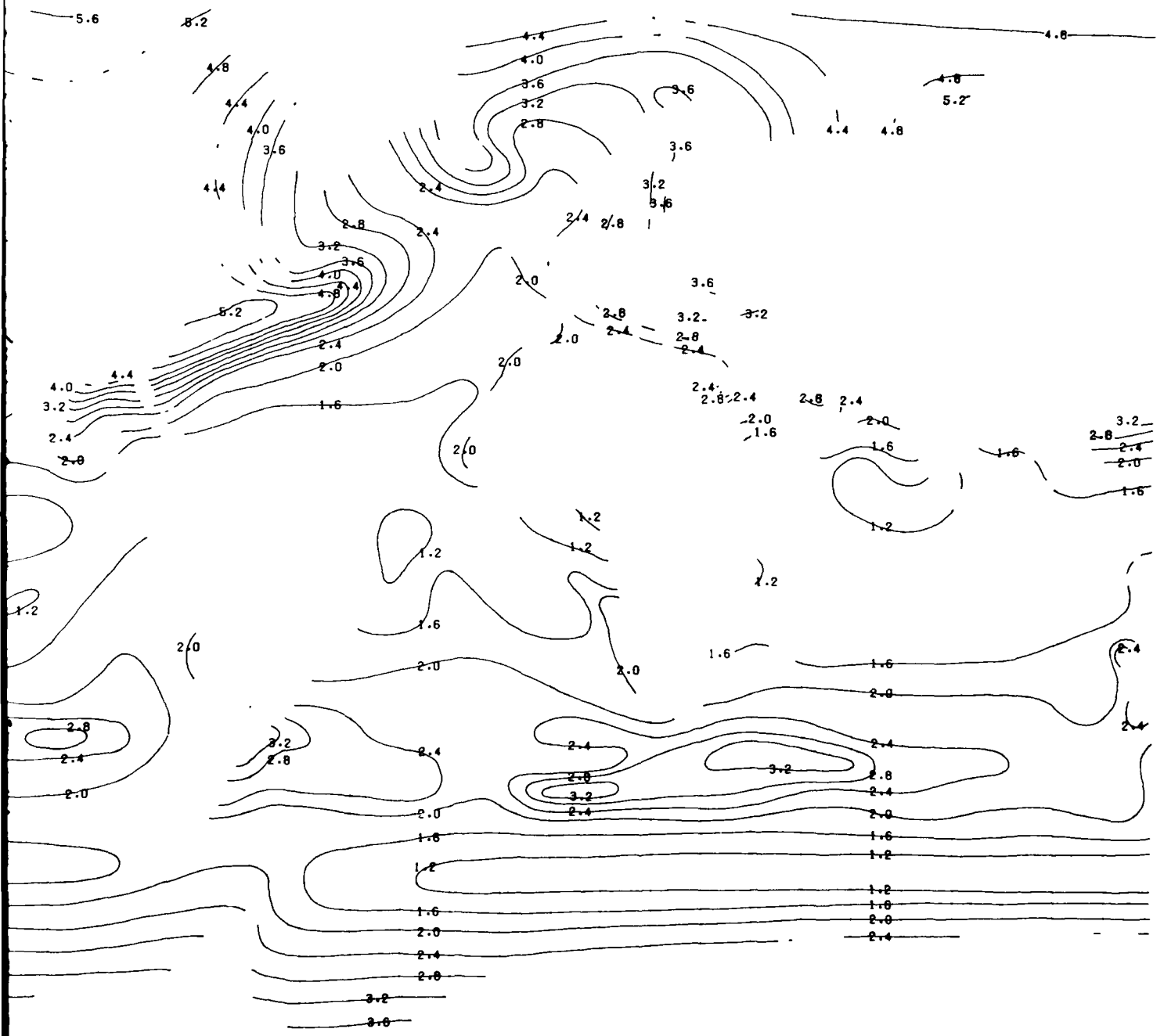

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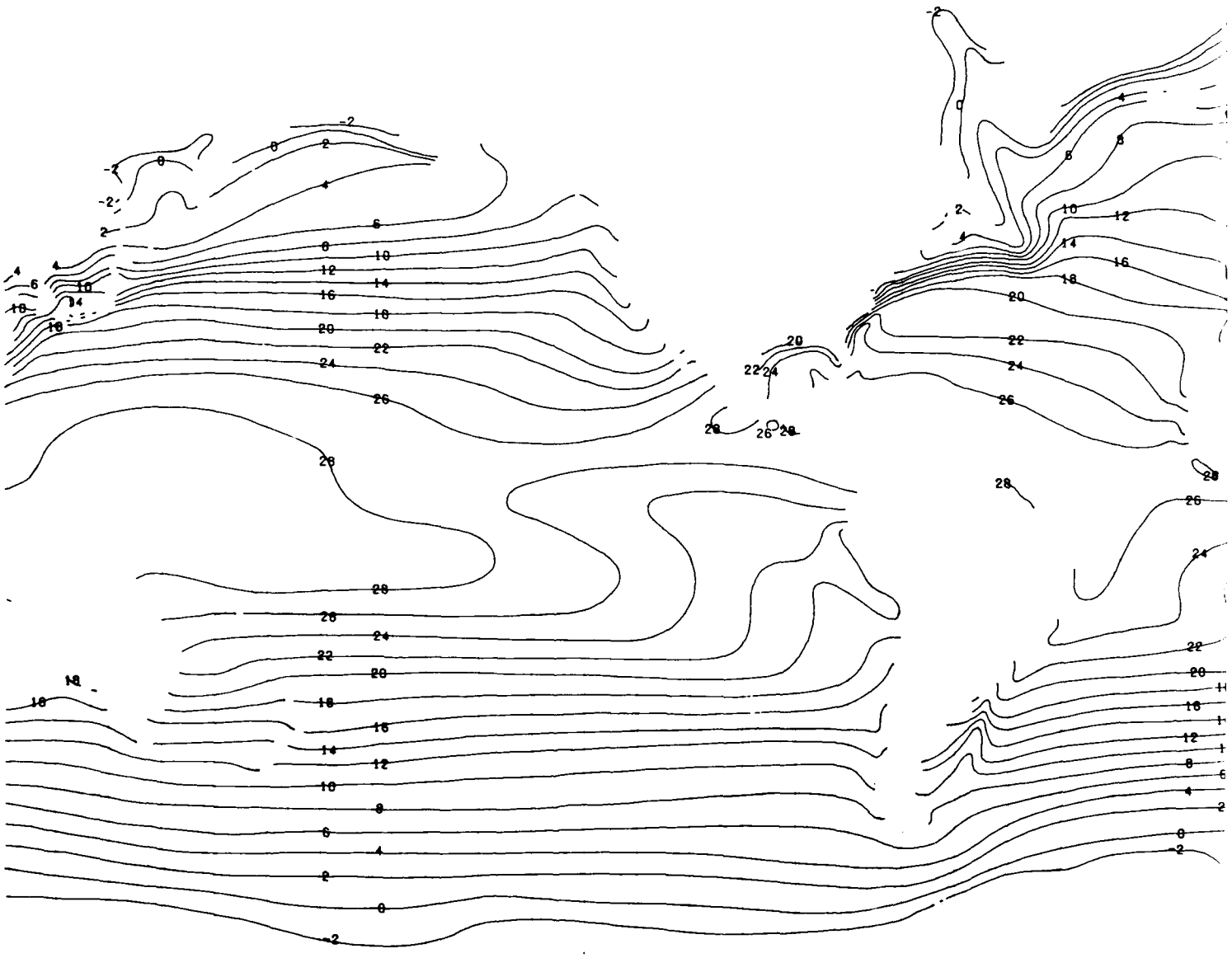
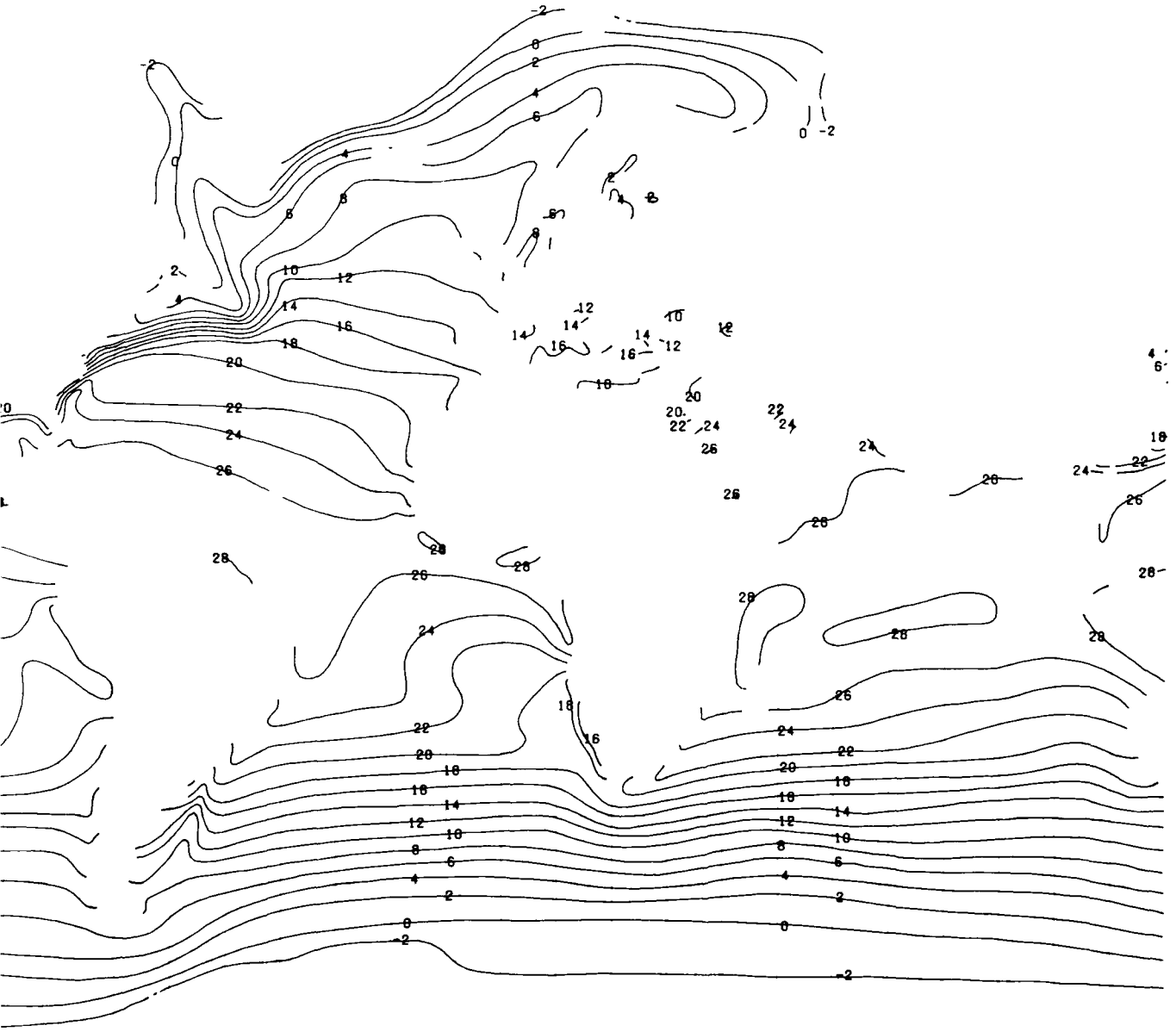
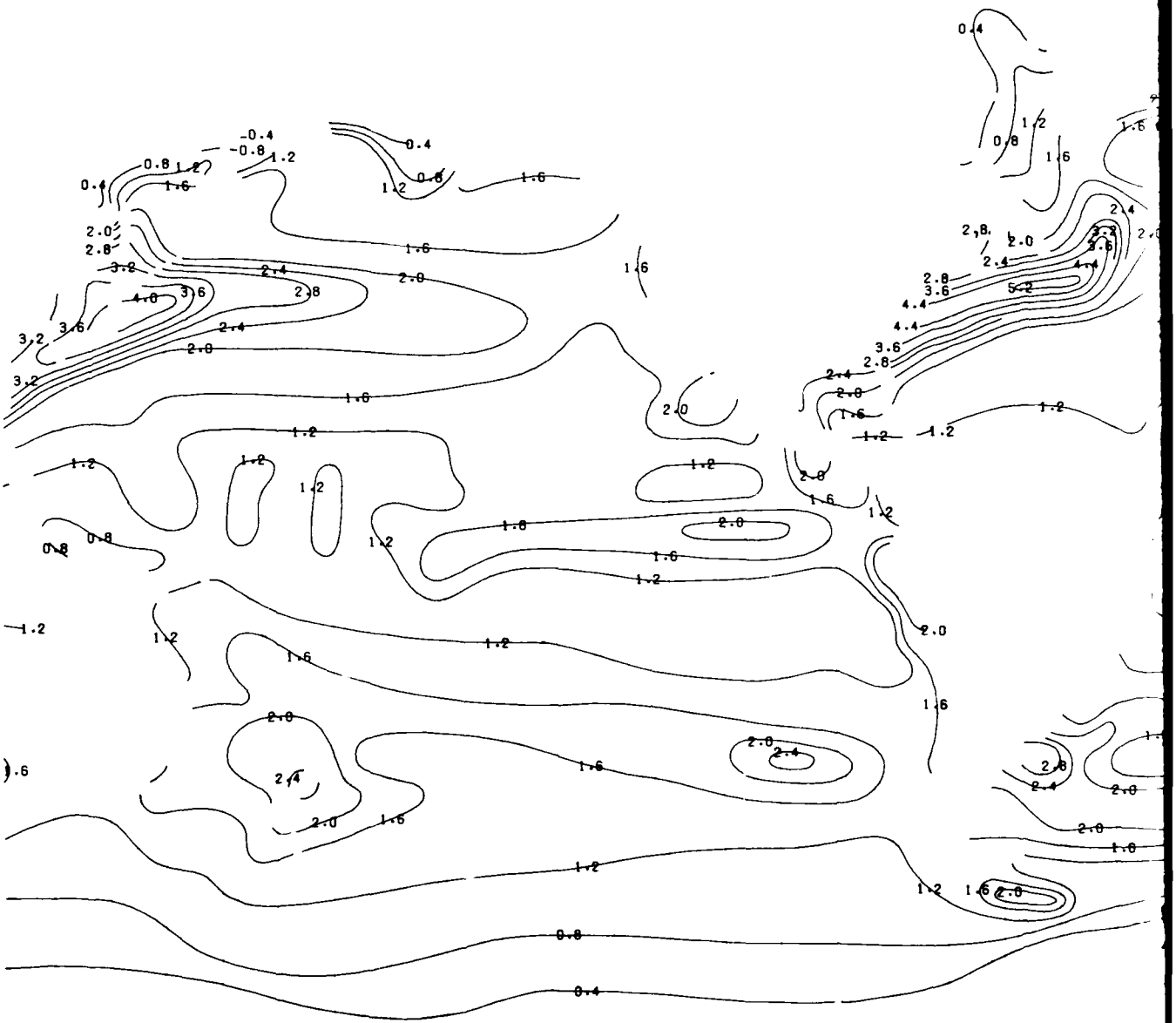


SEA SURFACE TEMPERATURE (°C) - MEANS



SEA SURFACE TEMPERATURE (°C) - STANDARD DEVIATIONS



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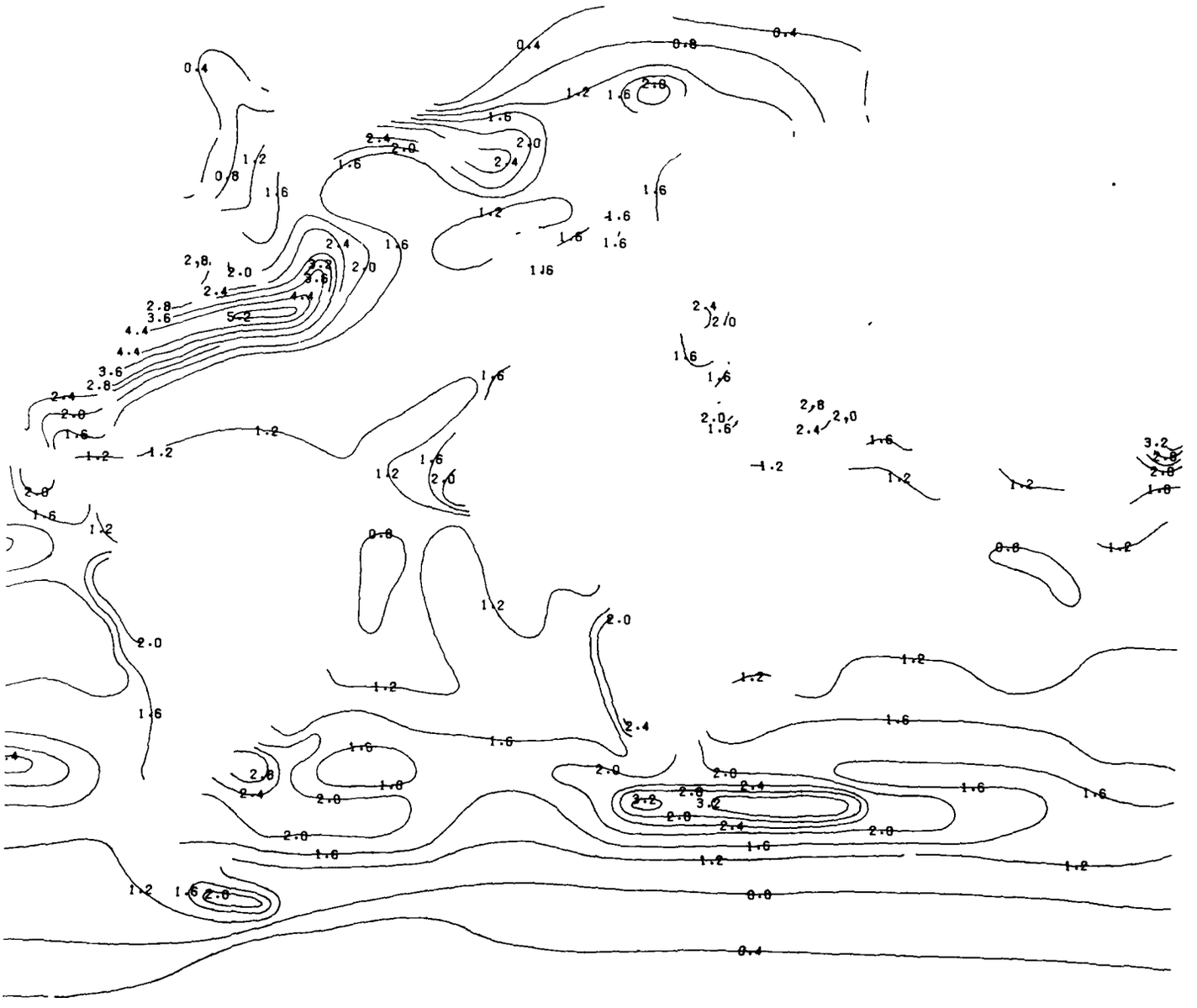

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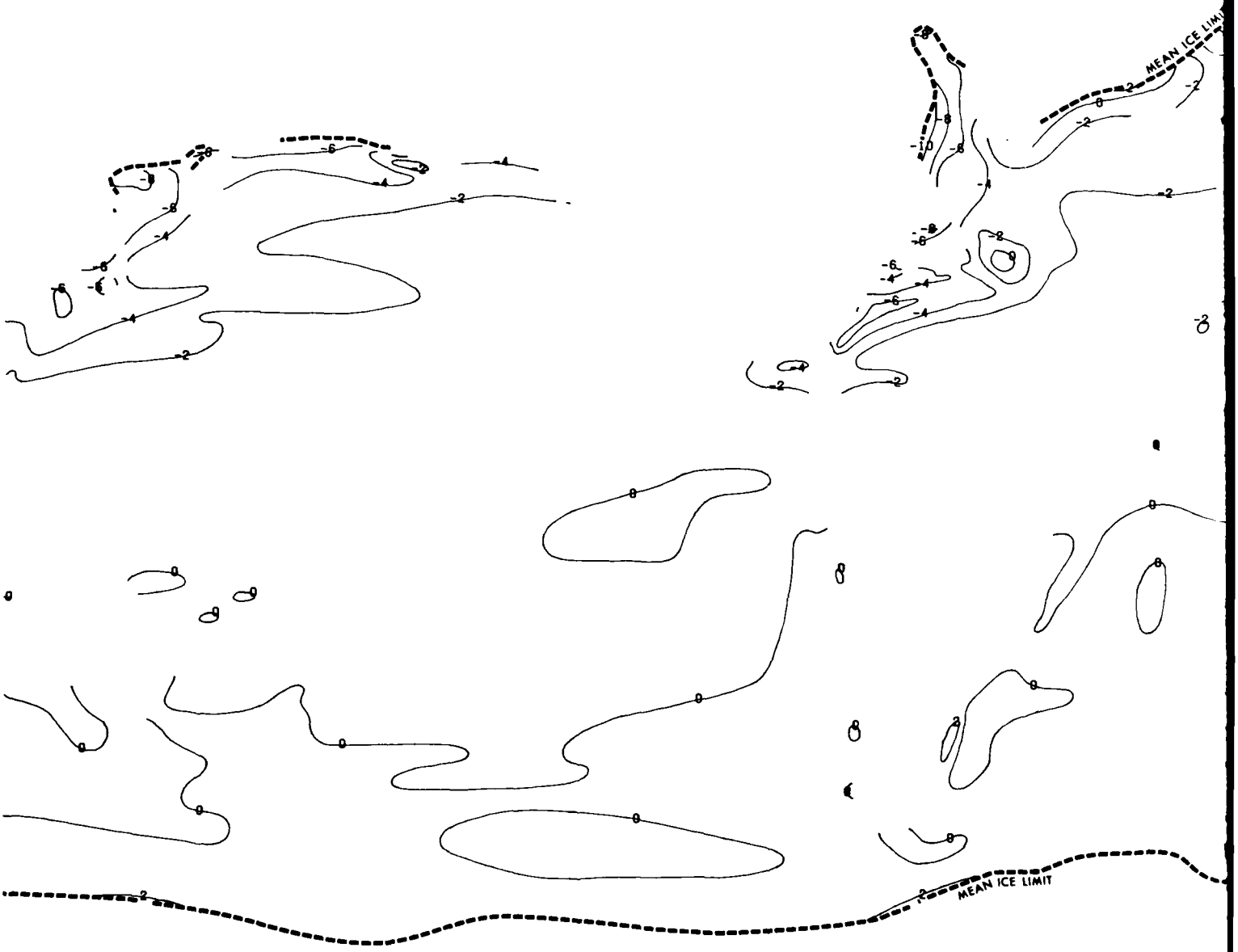
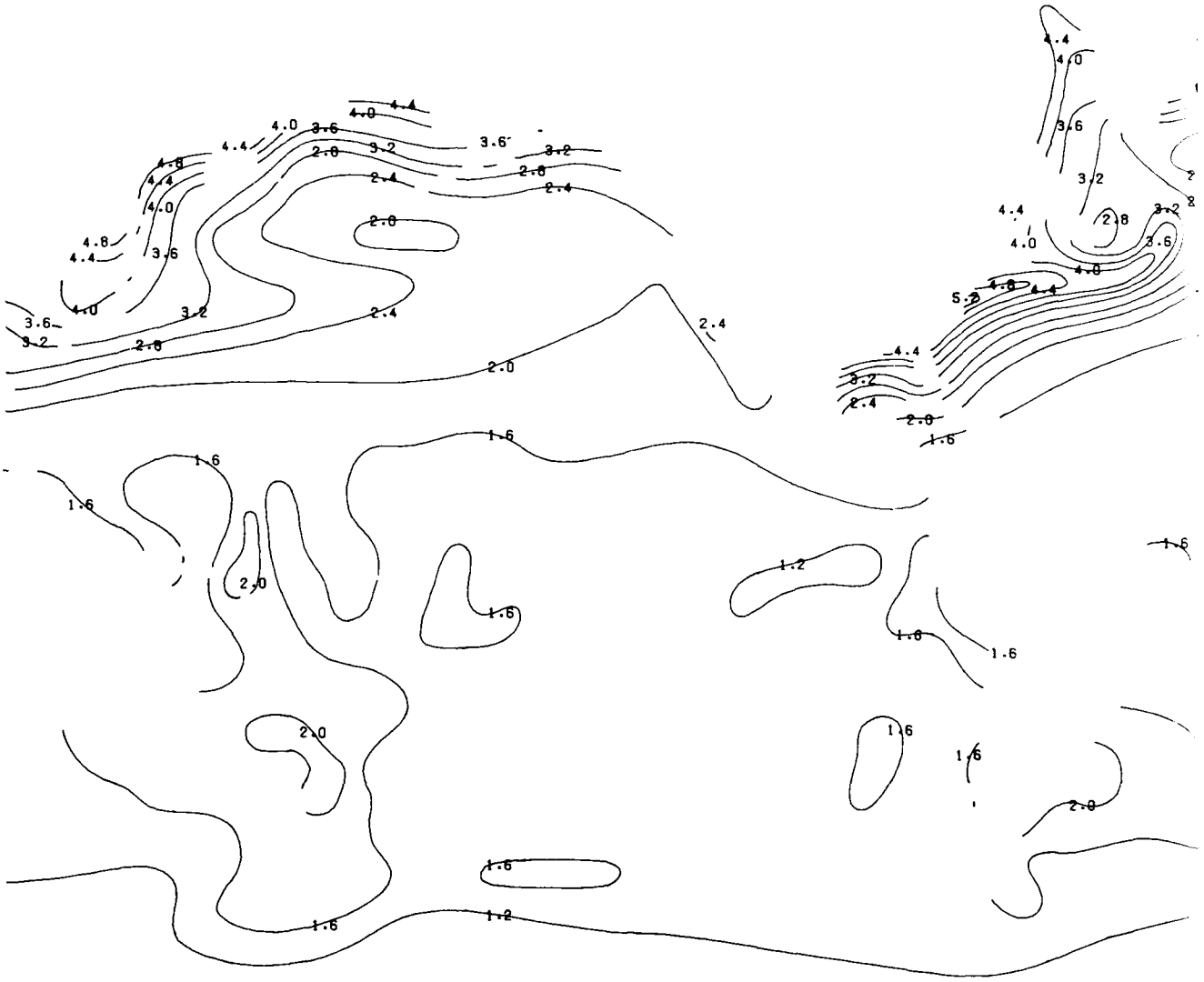


AIR-SEA TEMPERATURE DIFFERENCE (°C) - MEANS

AIR-SEA TEMPERATURE DIFFERENCE (°C) - STANDARD DEVIATIO



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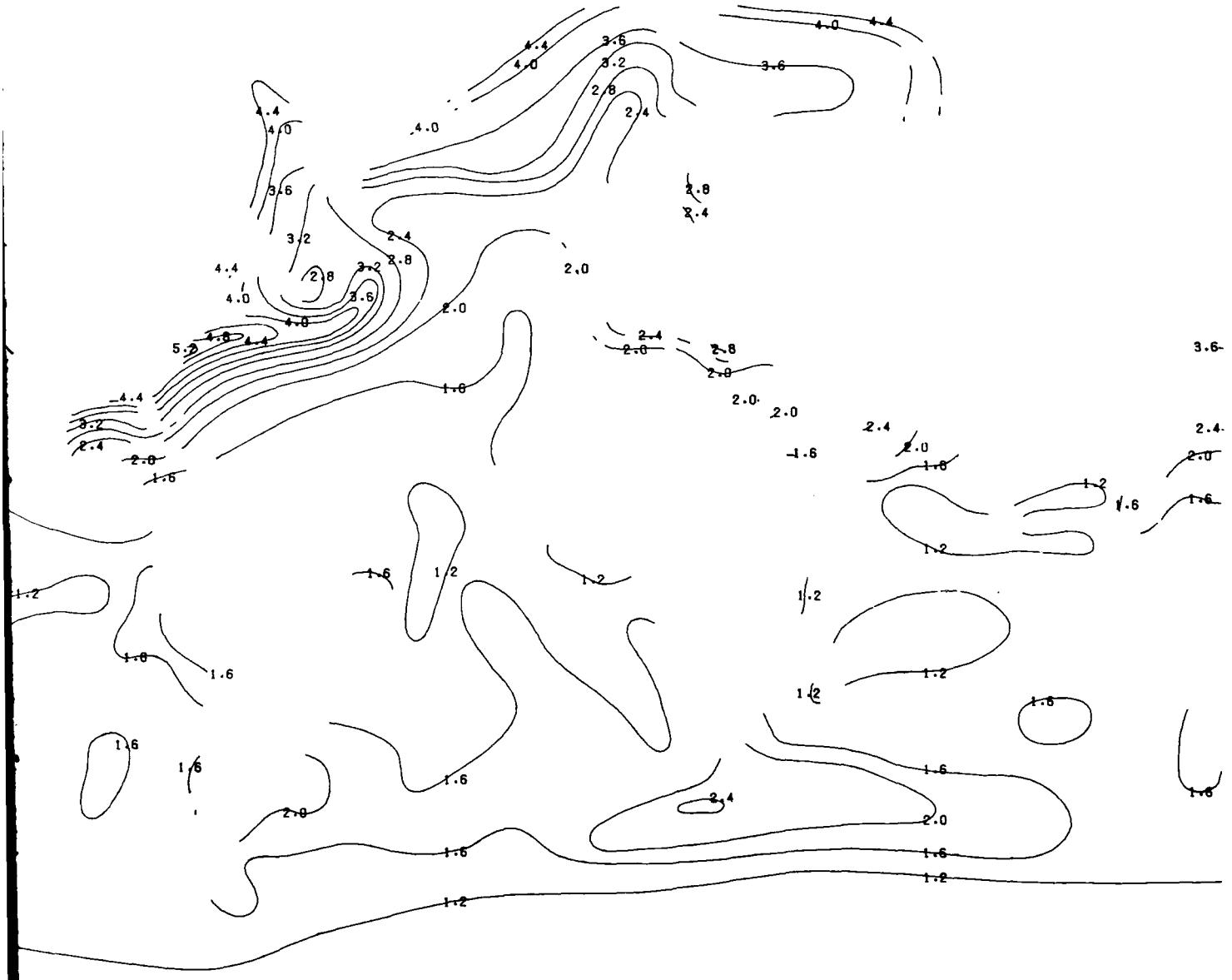

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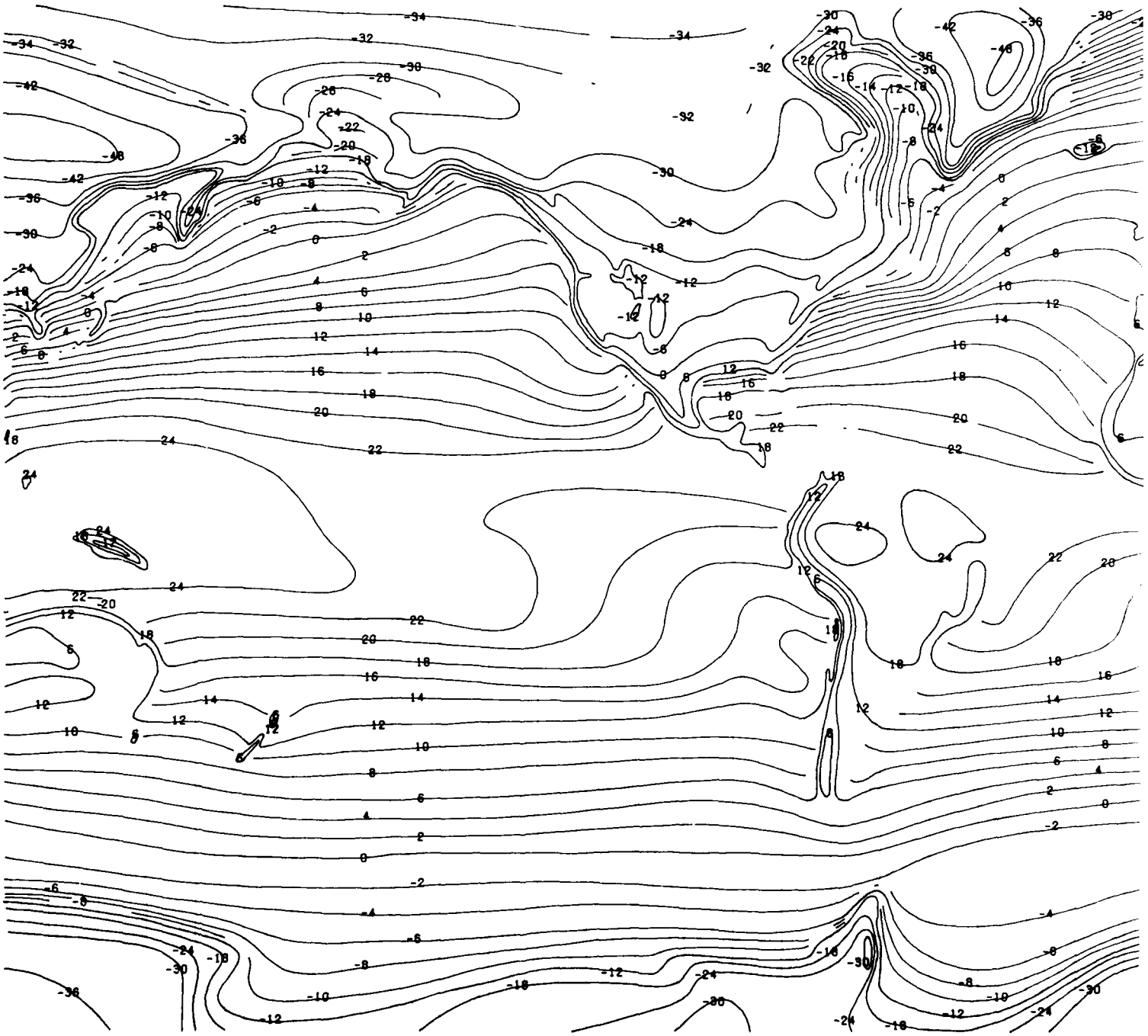
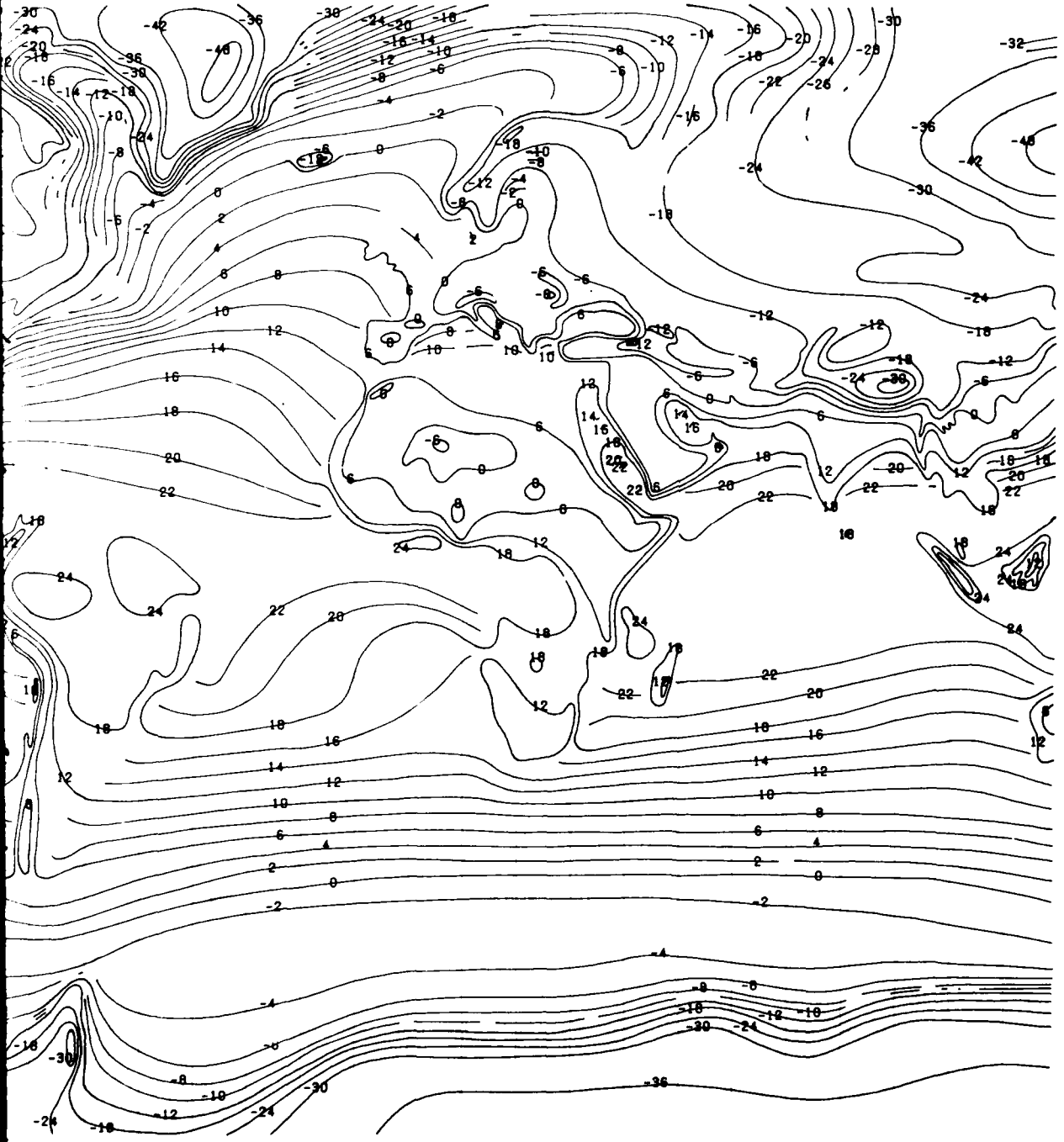
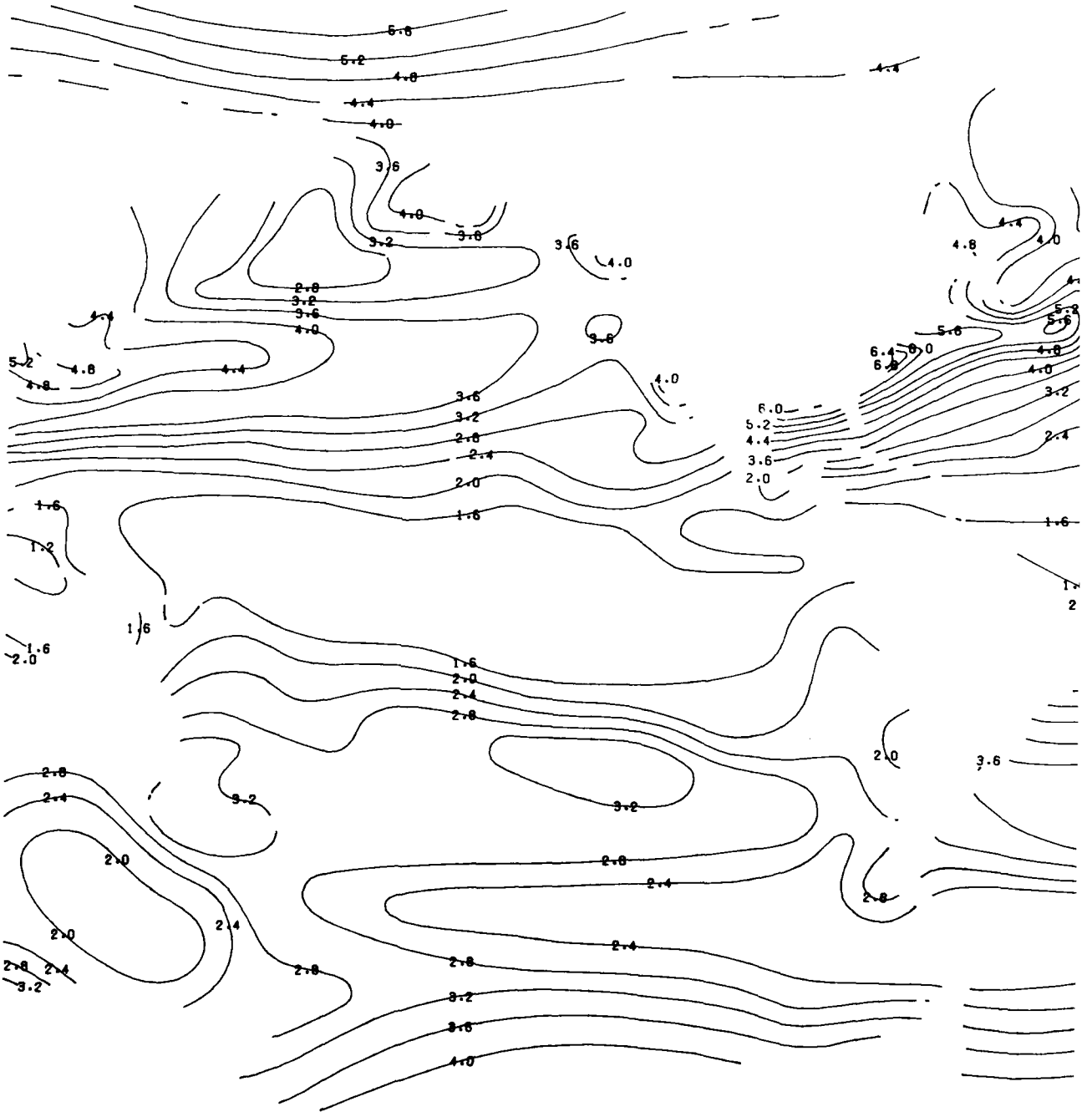


DEW-POINT TEMPERATURE (°C) - MEANS



DEW-POINT TEMPERATURE (°C) - STANDARD DEVIATIONS



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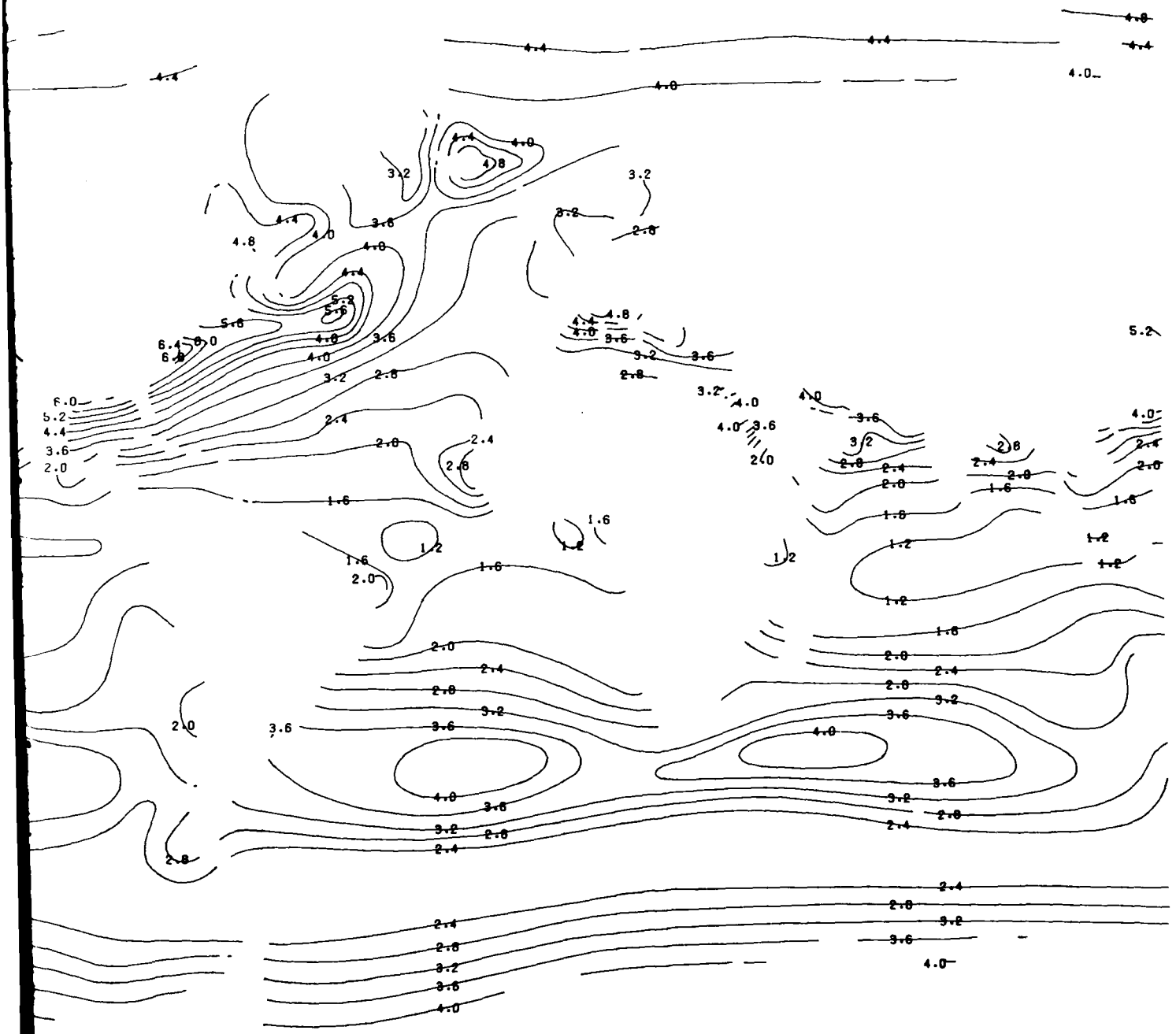

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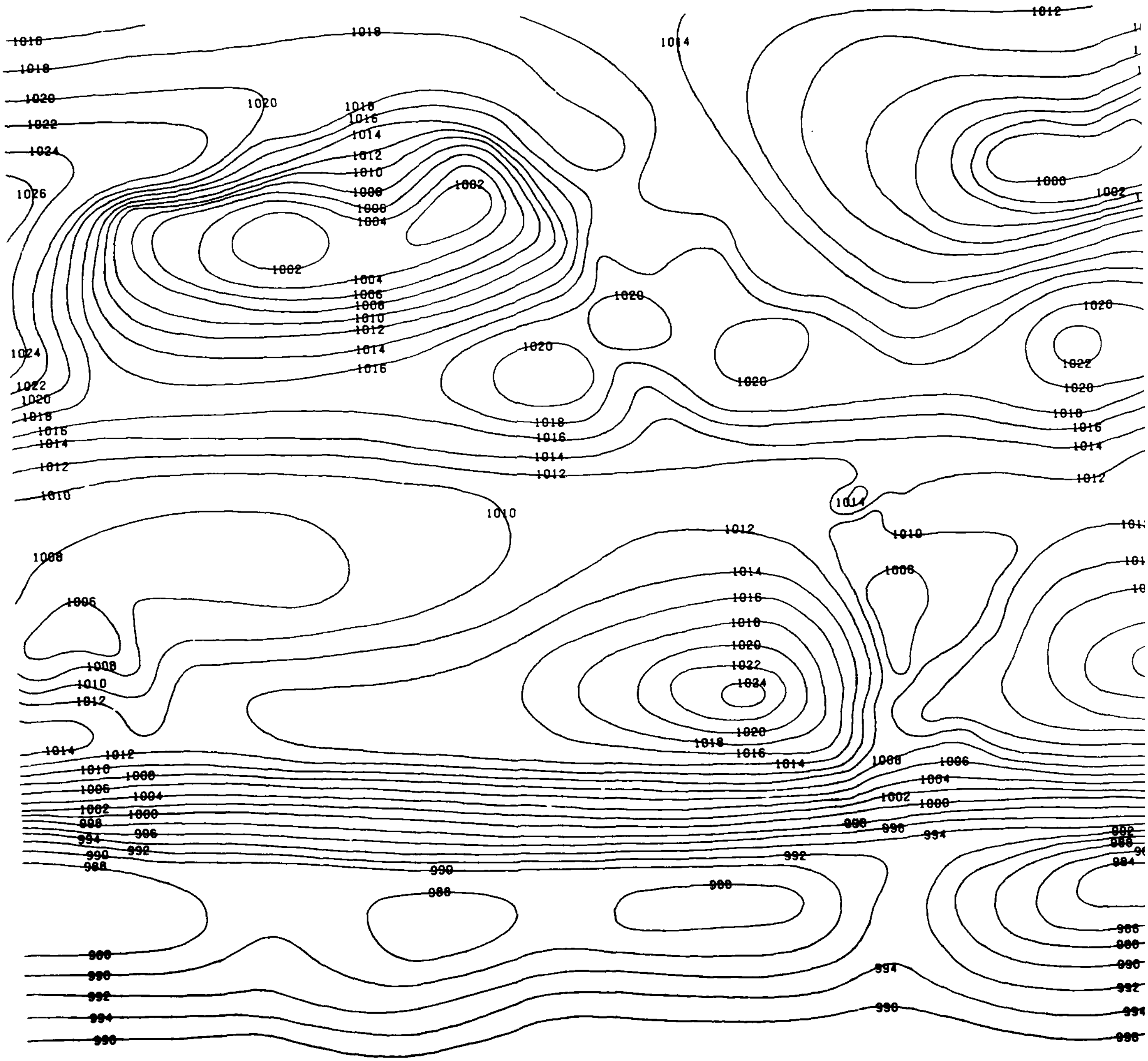

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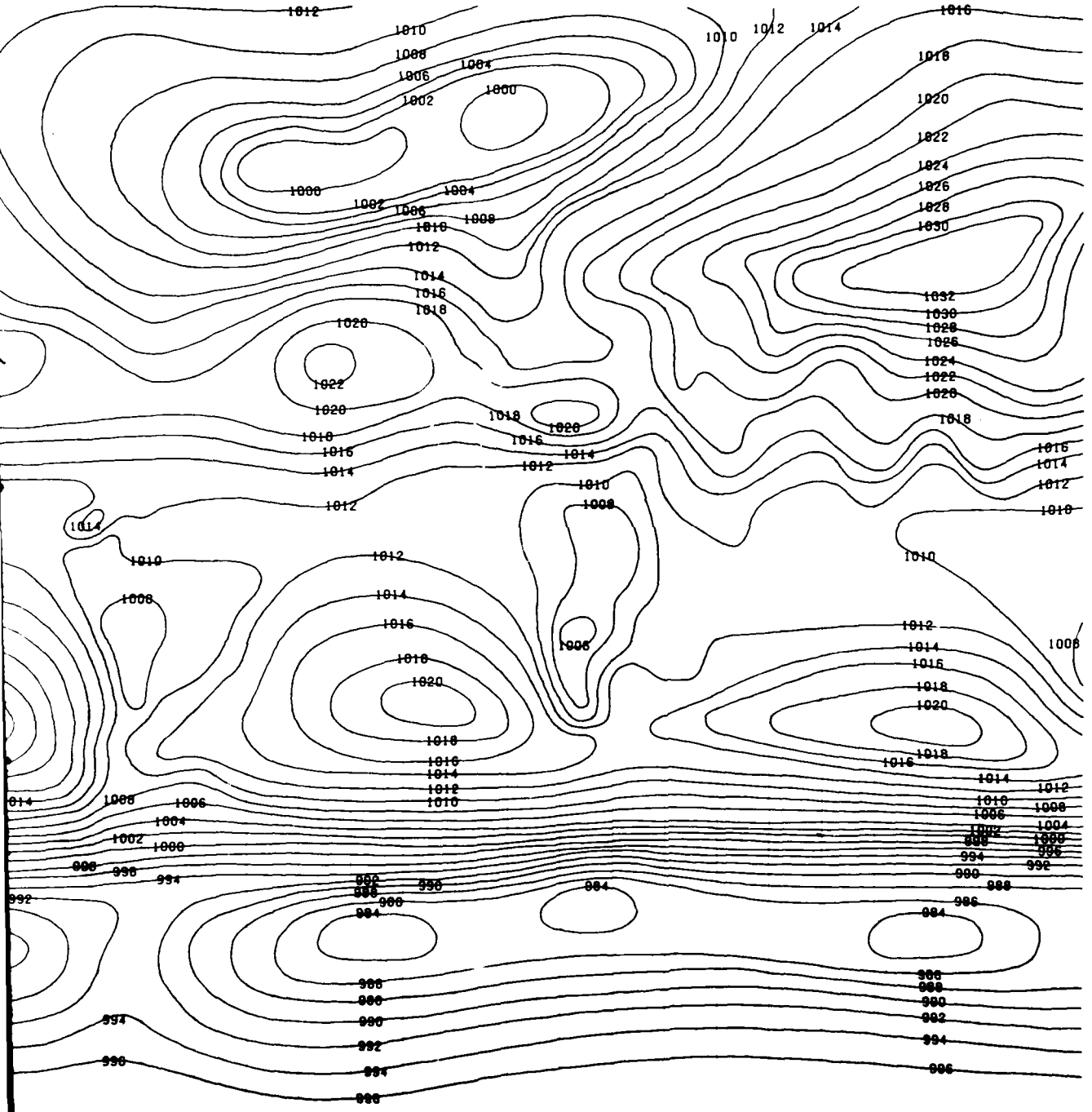
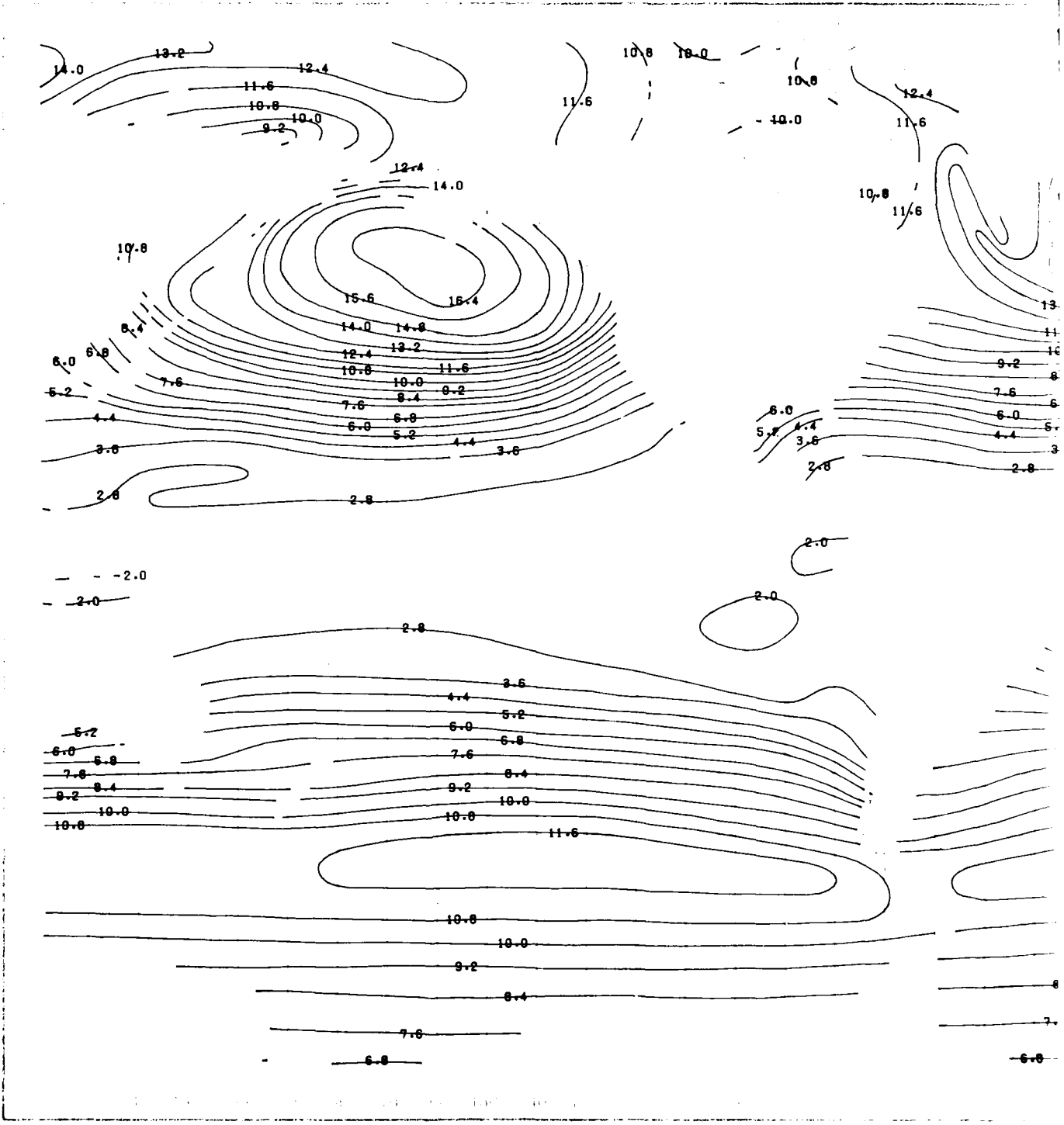
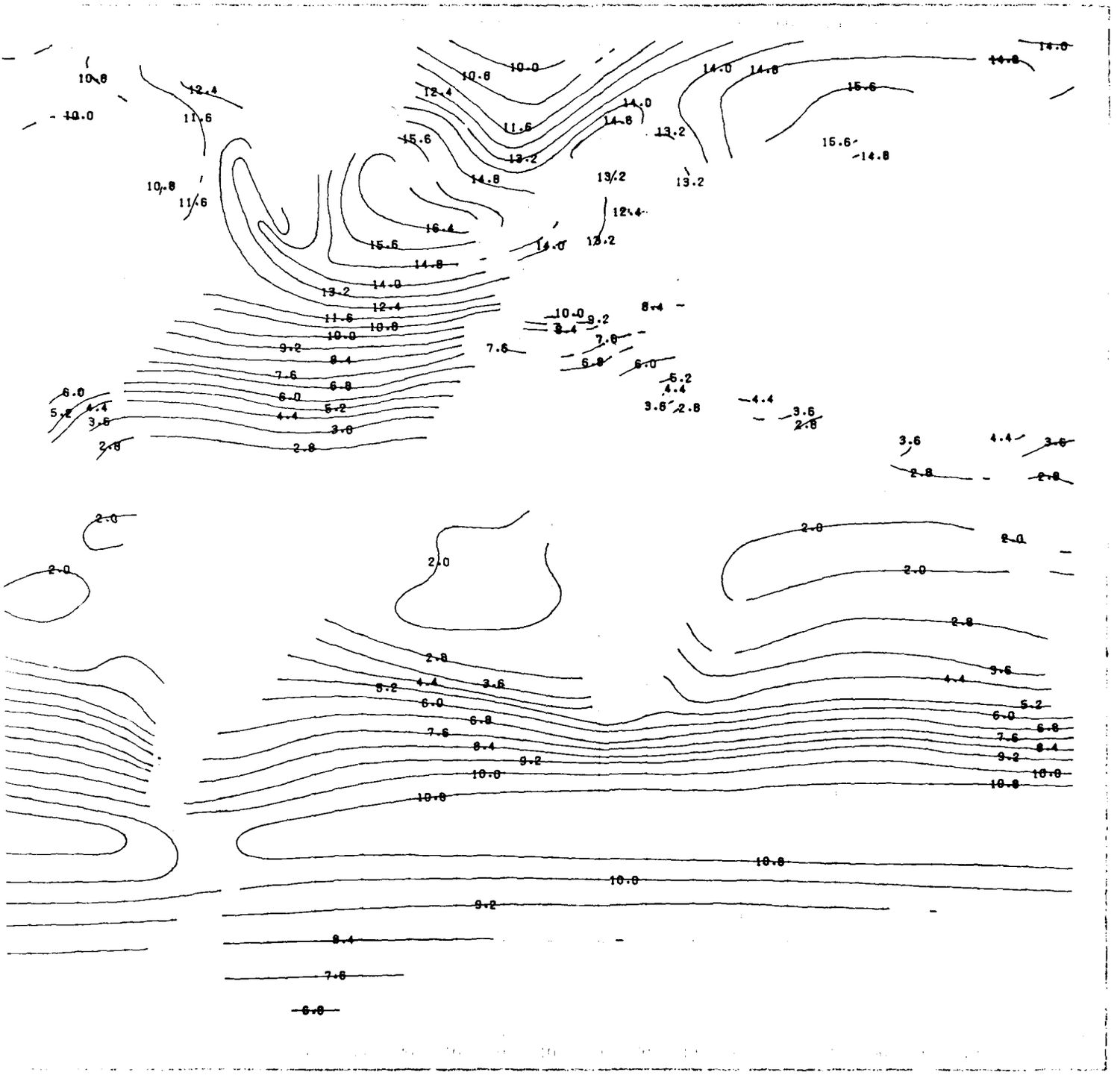
SEA LEVEL PRESSURE (MBS) - MEANS



SEA LEVEL PRESSURE (MBS) - STANDARD DEVIATIONS



DEVIATIONS DECEMBER



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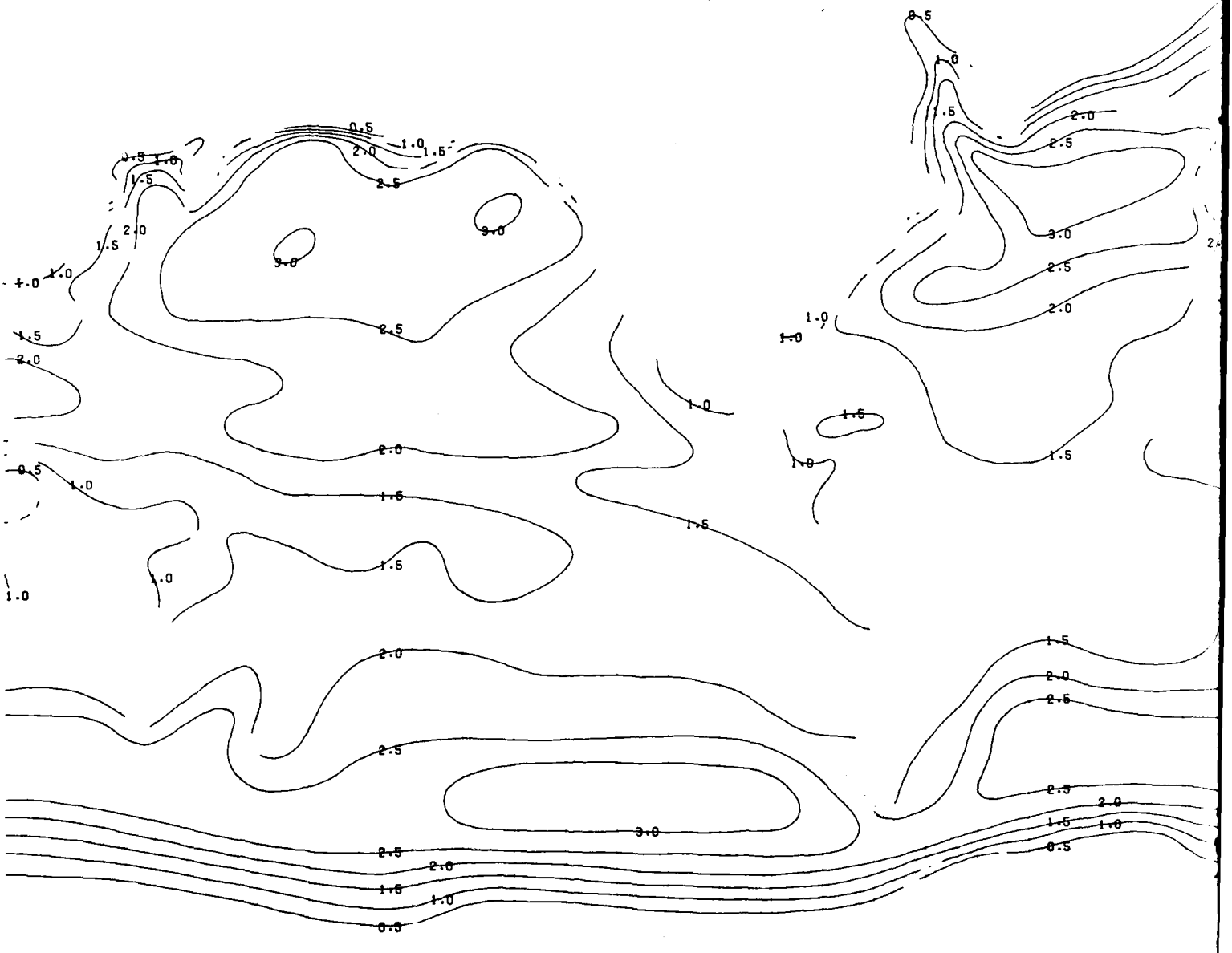
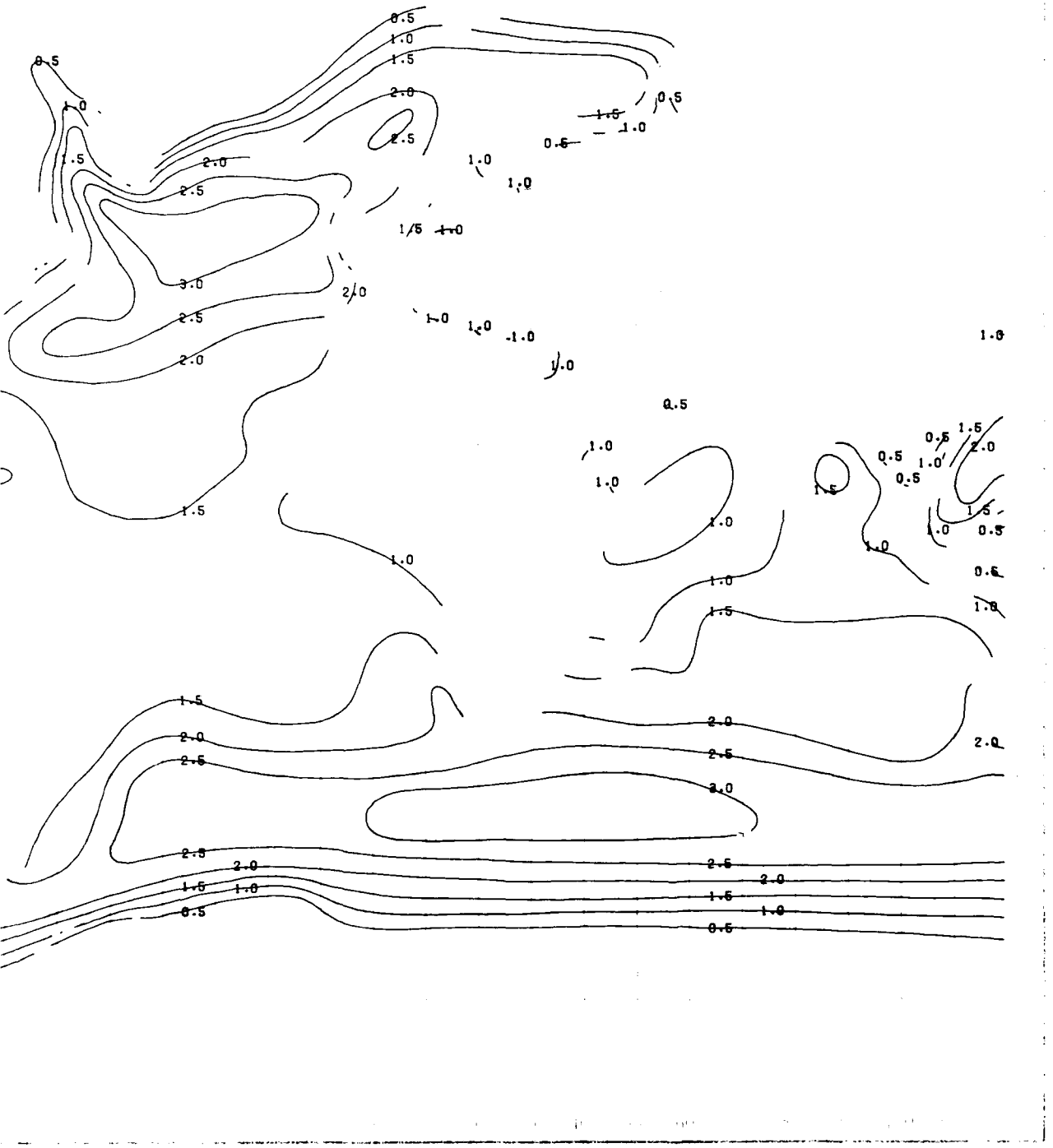
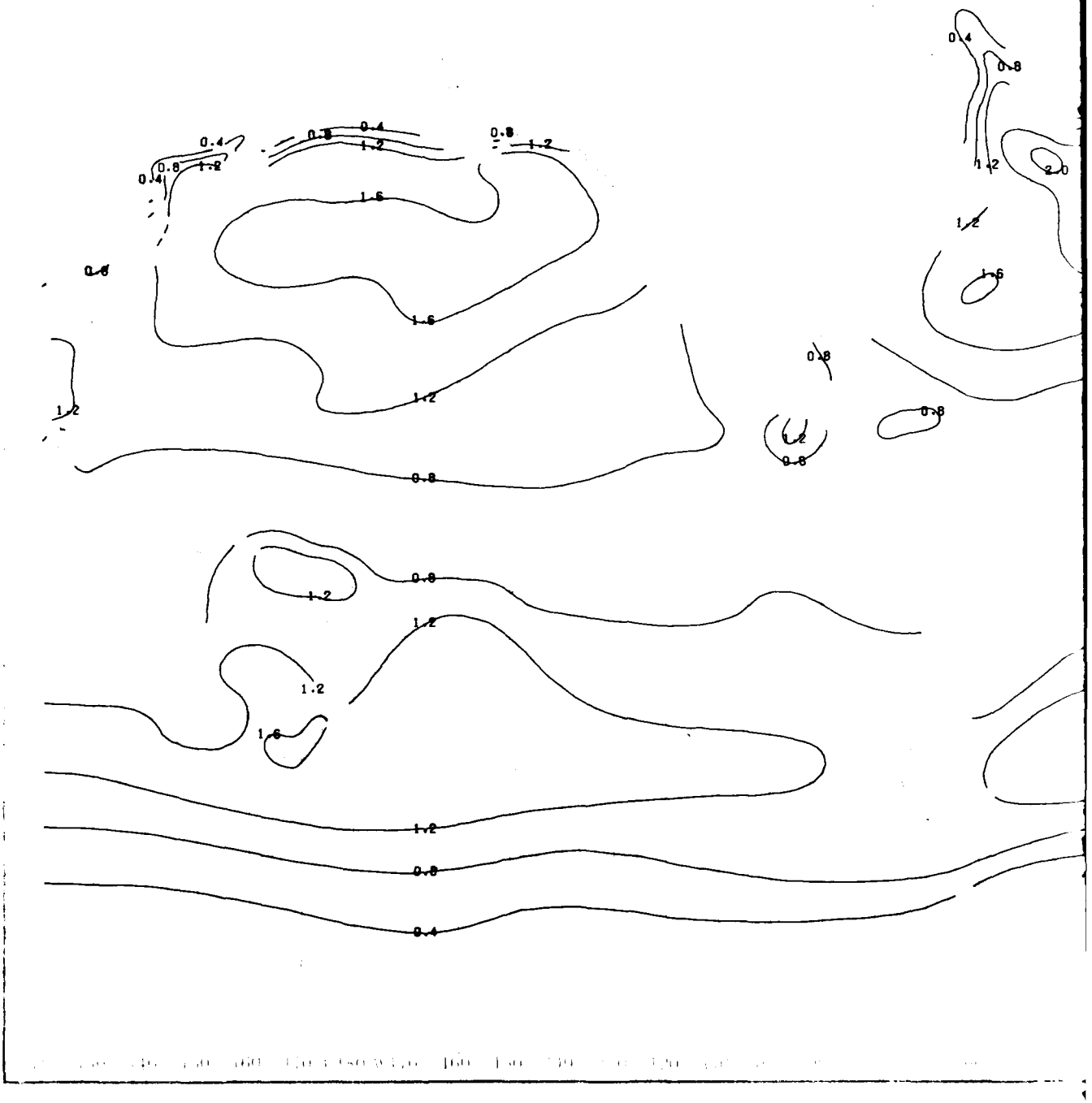
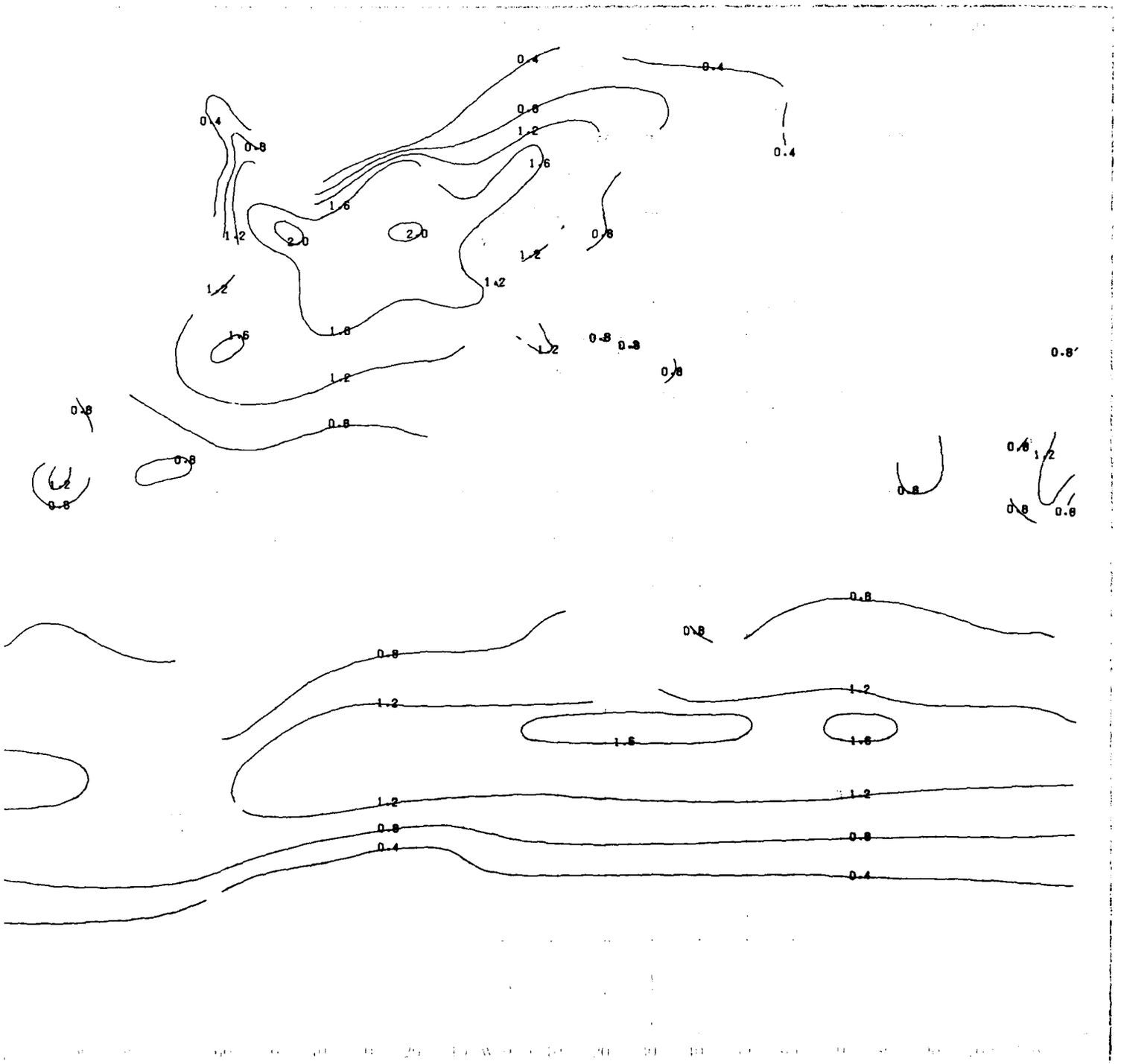


WAVE HEIGHTS (M) - MEANS



WAVE HEIGHTS (M) - STANDARD DEVIATIONS

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