

ANALYSIS OF RAINFALL OVER NORTHERN PERU
DURING EL NIÑO--A PCDS APPLICATION

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In an examination of GOES satellite data during the 1982 through 1983 El Niño period, the appearance of lee wave cloud patterns was revealed. A correlation was hypothesized--relating an anomalous easterly flow across the Andes with the appearance of these wave patterns and with the subsequent onset of intense rainfall. The cloud patterns are believed to be associated with the El Niño period and could be viewed as precursors to significant changes in weather patterns. The ultimate goal of the researchers will be the ability to predict occurrences of rainstorms associated with the appearance of lee waves and related cloud patterns as harbingers of destruction caused by flooding, huaycos, and other catastrophic consequences of heavy and abnormal rainfall. It is hoped that forecasting of such phenomena can alleviate some of the tragic effects associated with them.

Rainfall data from about 70 stations in northern Peru from 1980 through 1984 were formatted into CDFs to be utilized within the PCDS.* This time period includes the 1982 through 1983 El Niño period. As an example of the approach, a well-pronounced lee wave pattern was shown from a GOES satellite image of April 4, 1983. The ground truth data were then displayed via the PCDS to graphically demonstrate the increase in intensity and areal distribution of rainfall in the northern Peruvian area in the next 4 to 5 days. The graphical technique used to display the rainfall ground truth included a sequence of histograms, contour plots, and three-dimensional surface diagrams.

An exciting consequence of this investigation is the researchers' plan to quantify the available GOES satellite cloud data (on an IBM PC) and to transfer it to the PCDS for further analysis. This use of the PCDS to integrate satellite and nonsatellite data should prove to be extremely beneficial in future research.

*This is a user produced data set and is not available to other users at this time.

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**Analysis of Rainfall over
Northern Peru During El Niño:
A PCDS Application**

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Peru**

Project PREPAREN:
GOES/METSAT Applications
for Disaster Early Warning
in Ecuador and Peru

(*PRE*cipitation *PAT*terns Related to *El Niño*)

Sponsor:

Technical Officer:

Study Scientist:

Visiting Scientist:

P. Krumpe (AID/OFDA)

L. Steyaert (NOAA)

R. Goldberg (NASA)

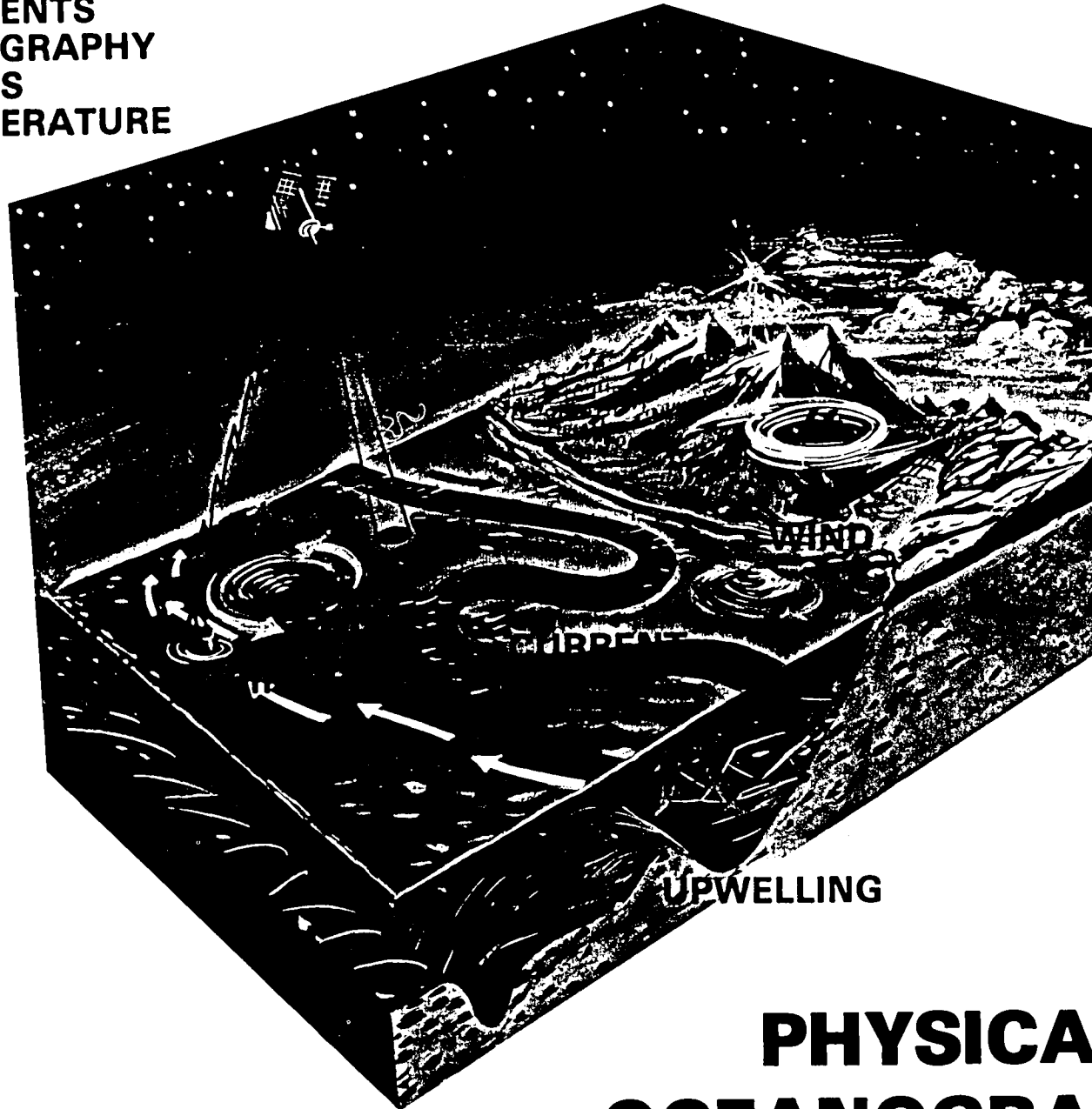
G. Tisnado (INAIT/Peru)

Project PREPAREN – Objective

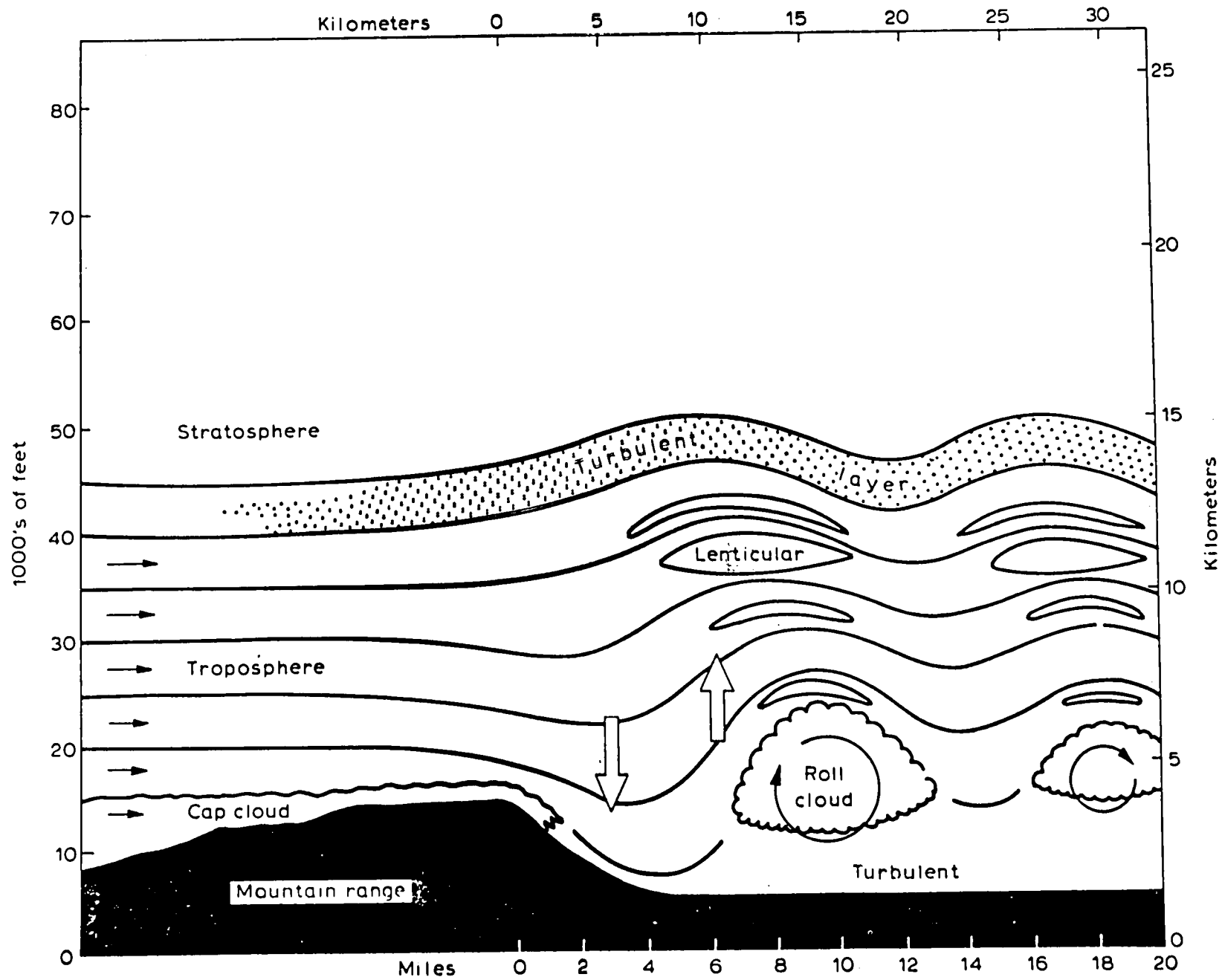
To investigate associations between lee wave cloud patterns and extreme rainfall events in coastal regions of Northern Peru and Ecuador to develop flood alert models for these regions.

OCEAN CIRCULATION

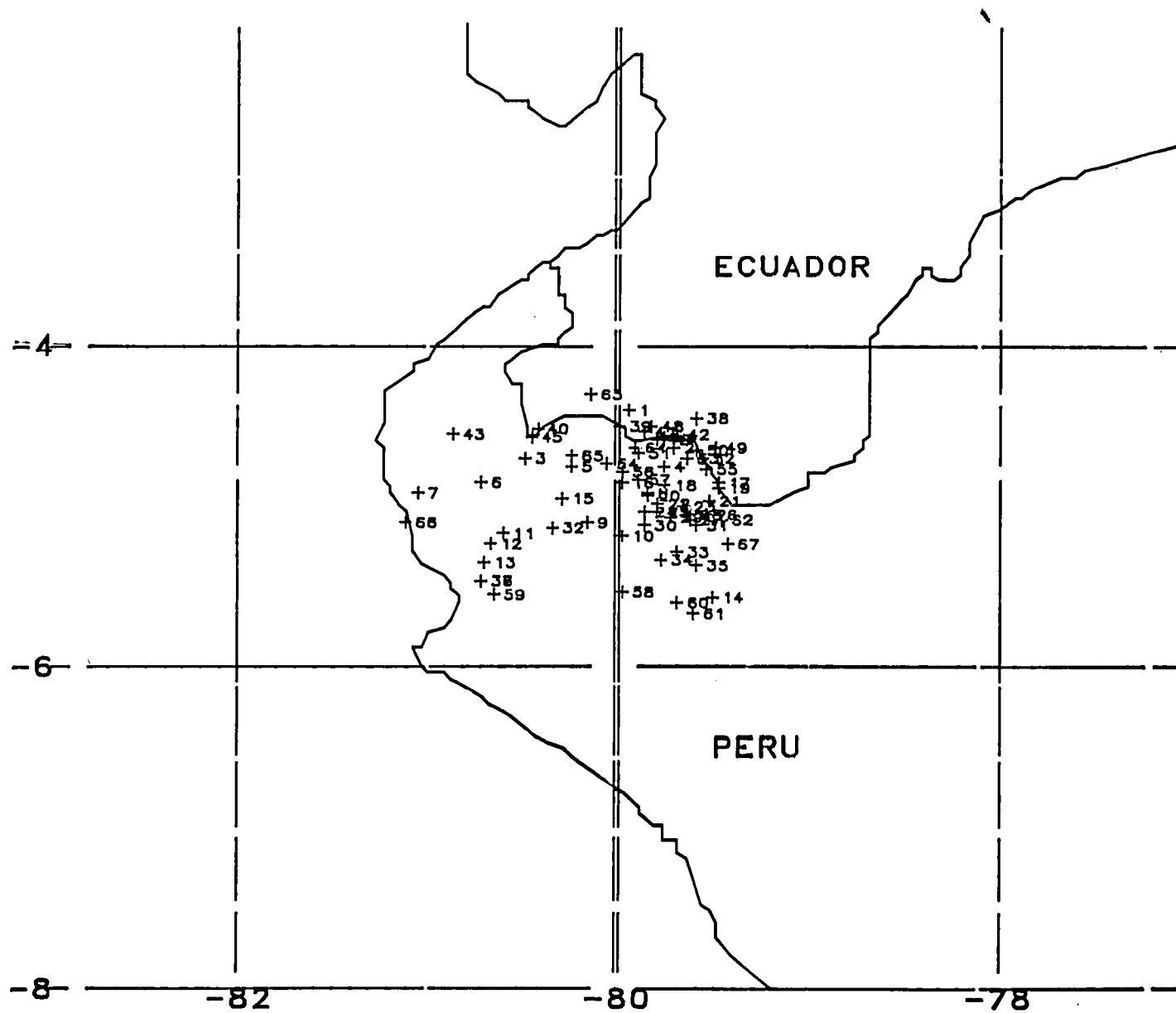
- CURRENTS
- TOPOGRAPHY
- WINDS
- TEMPERATURE



PHYSICAL OCEANOGRAPHY

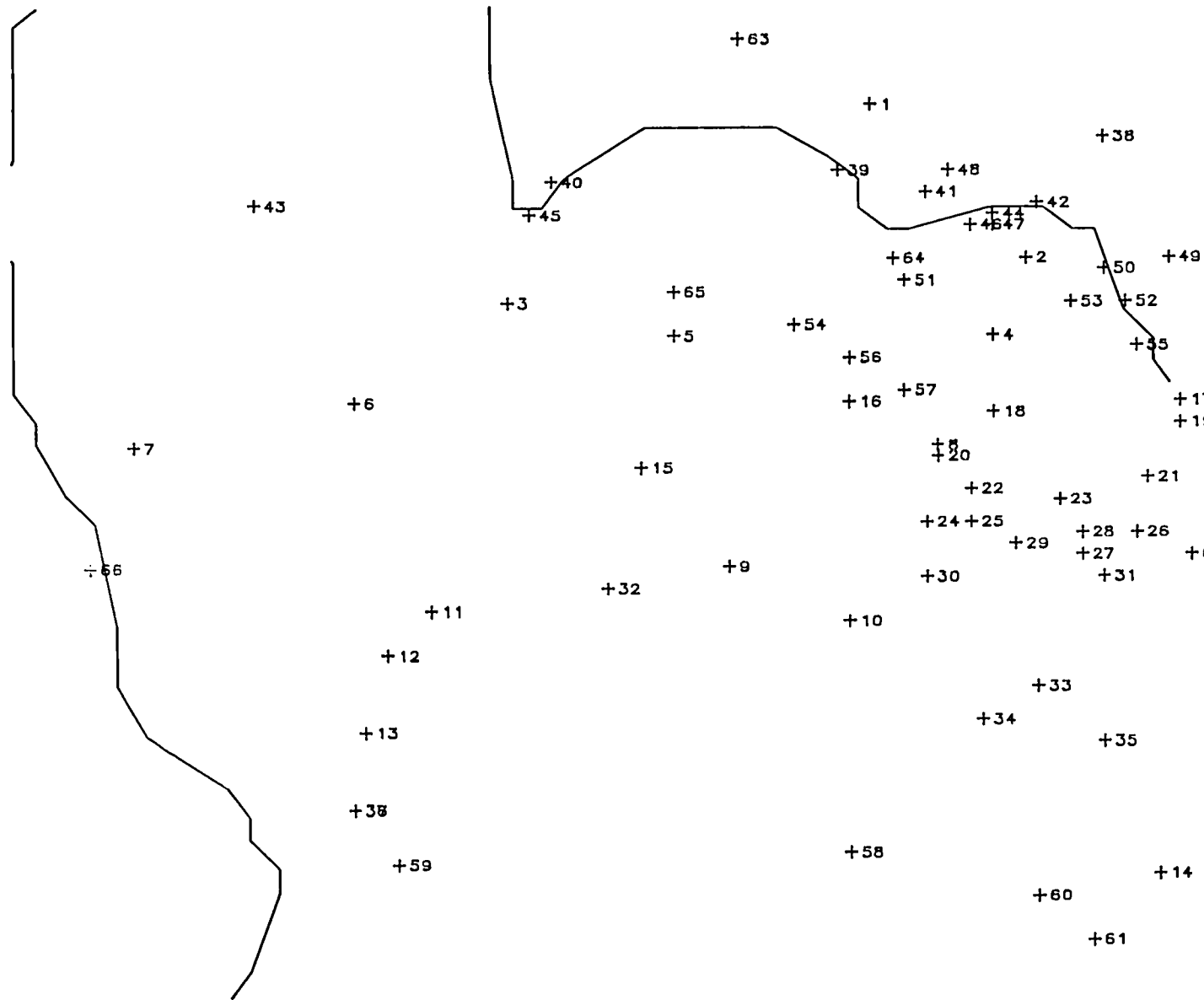


Peruvian Rainfall Stations



- 1 LA TINA
- 2 AYABACA
- 3 CHILACO
- 4 SAUSAL DE CULUCAN
- 5 TEJEDORES
- 6 MALLARES
- 7 LA ESPERANZA
- 8 ARENALES
- 9 CHILUCANAS
- 10 MORROPON
- 11 MIRAFLORES
- 12 SAN BIQUEL
- 13 MONTEGRANDE
- 14 HUANRACA
- 15 CORPIC
- 16 ARANZA
- 17 ANTA
- 18 MANGAY DE NATALACAS
- 19 LAGUNA SECA
- 20 FRIAS
- 21 LOS ALISOS
- 22 PIRCA
- 23 PACATPAMPA
- 24 SANTO DOMINGO
- 25 CHALACO
- 26 TALAHO
- 27 SAN PEDRO
- 28 PALO BLANCO
- 29 ALTARIZA
- 30 PALTASHACO
- 31 PASAPAMPA
- 32 SAN JOAQUIN
- 33 BARRIOS
- 34 BIGOTE
- 35 CANCHACHE
- 36 BERNAL
- 37 CHASIS
- 38 YAGO GRANDE
- 39 SUYO
- 40 ARDILLA
- 41 PICO DE LORD
- 42 CERRO MENDRILLO
- 43 PANAMBA
- 44 STOCHES
- 45 LANCOMES
- 46 JILLI
- 47 HUNRA DE VEXAS
- 48 MONTERO
- 49 ESPINOLA
- 50 TACALPO
- 51 TONIA DE ZAMBA
- 52 TIPULCO
- 53 OLLEROS
- 54 LAGARTERA
- 55 TAPIL
- 56 SAPILLICA
- 57 ARREDOAMIENTOS
- 58 VIRRET
- 59 LAGUNA RAMON
- 60 CHICHA
- 61 PIRCA
- 62 HUNR HUNR
- 63 CIRUELO
- 64 PARAJE GRANDE
- 65 LAS LOMAS
- 66 PATTA
- 67 HUANCABAMBA

Peruvian Rainfall Stations



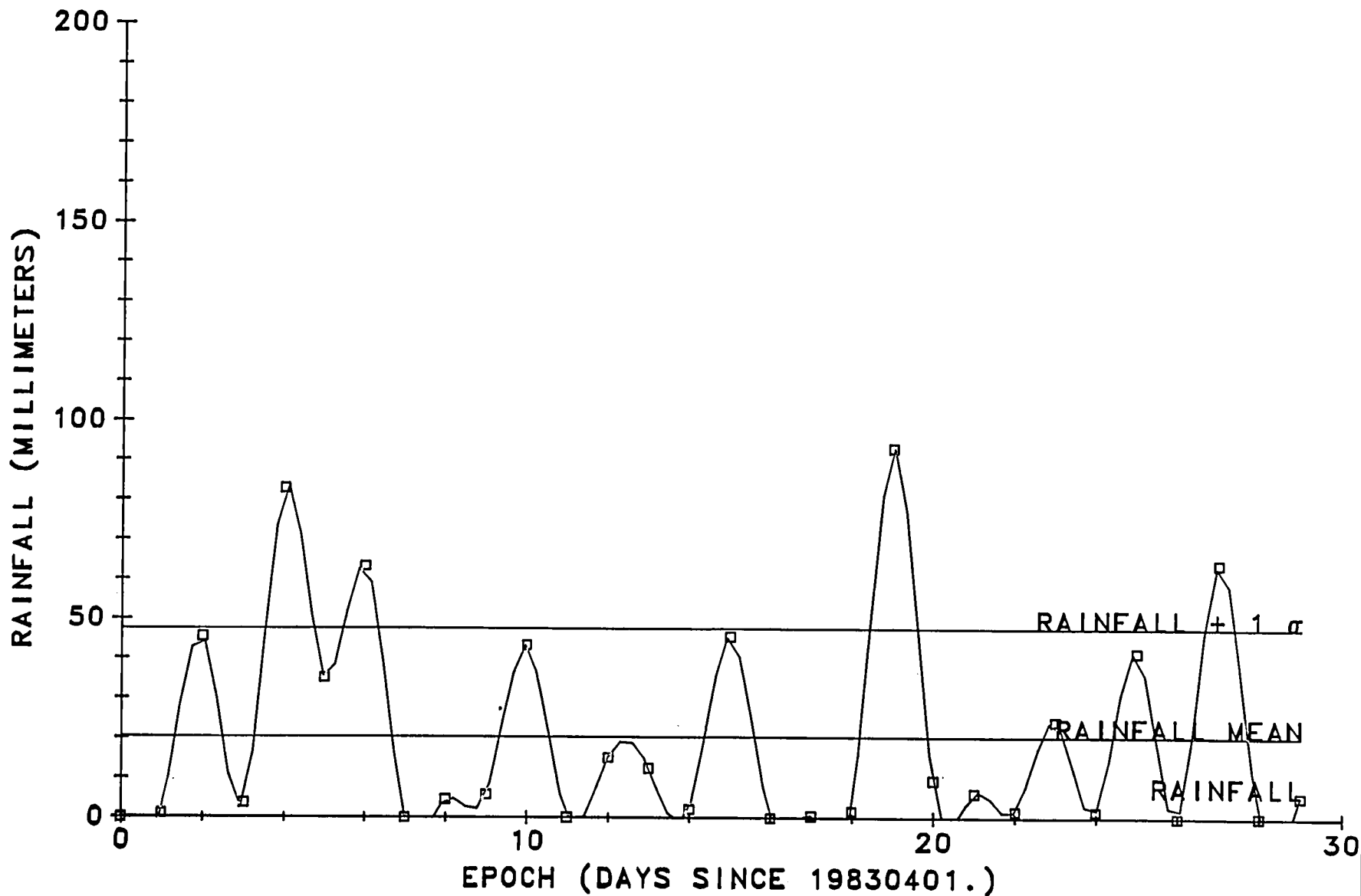
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- 14 HUAYACA
- 15 CORPAC
- 16 ARANZA
- 17 ANTA
- 18 MANGAY DE MATALACAS
- 19 LAGUNA SECA
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- 21 LOS ALISOS
- 22 PIRCAS
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- 29 ALTAMIZA
- 30 PALTASHACO
- 31 PASAPAMPA
- 32 SAN JOAQUIN
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- 35 CANCHAGUE
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- 40 ARDILLA
- 41 PICO DE LORO
- 42 CERRO MEMERILLO
- 43 PANAMCA
- 44 SICCHEZ
- 45 LANCONES
- 46 JILLI
- 47 HUARA DE VERAS
- 48 MONTEIRO
- 49 ESPINOLA
- 50 TACALPO
- 51 TOMA DE ZAMBA
- 52 TIPULCO
- 53 OLLEROS
- 54 LACARTEPA
- 55 TAPAL
- 56 SAPILLICA
- 57 ARRENDAMIENTOS
- 58 VIREY
- 59 LAGUNA RAMON
- 60 CHICHA
- 61 PIRCA
- 62 HUAR HUAR
- 63 CIRUELO
- 64 PARAJE GRANDE
- 65 LAS LOMAS
- 66 PAITA
- 67 HUANCABAMBA

April 1983

PLOTTED BY PCDS ON 17-OCT-85

Rainfall History for Mallares, Peru
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA

30 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING



6 < STATION (NUMBER) < 6

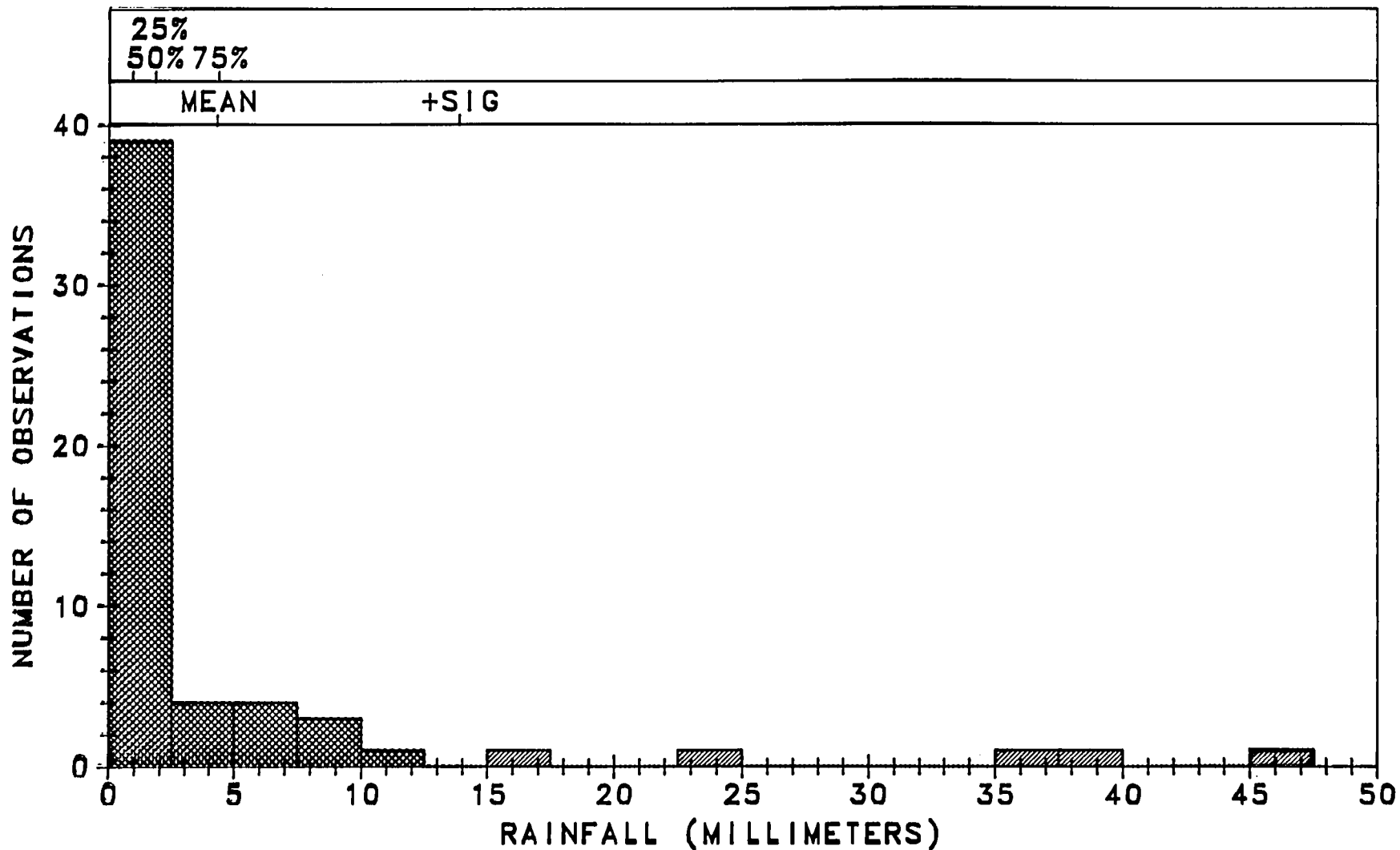
Apr 1 183

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Histogram for April 3, 1983

PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA

56 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING



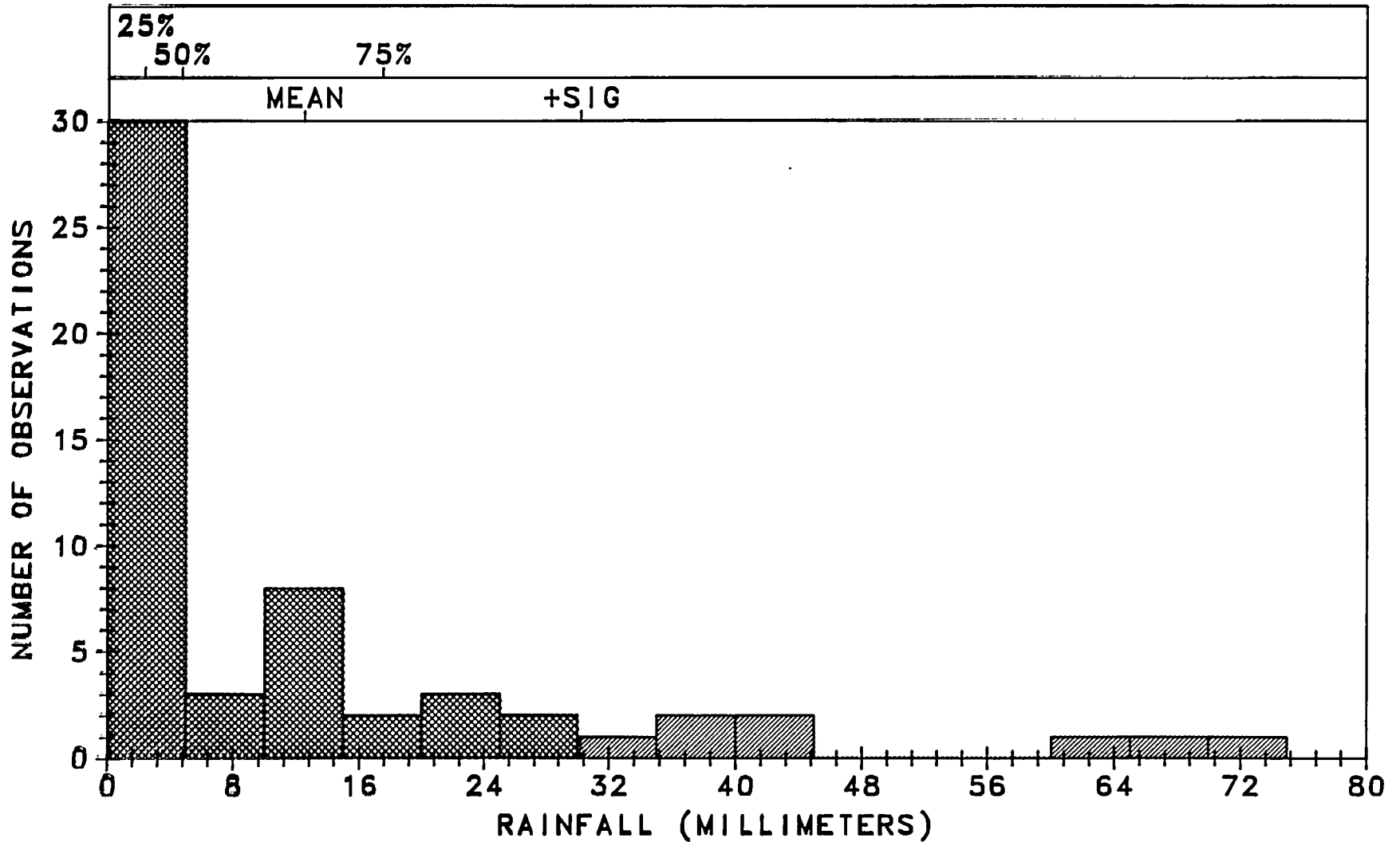
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0.000 < EPOCH (SEC. OF DAY) < 0.000

Apr1183

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Histogram for April 4, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
56 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING

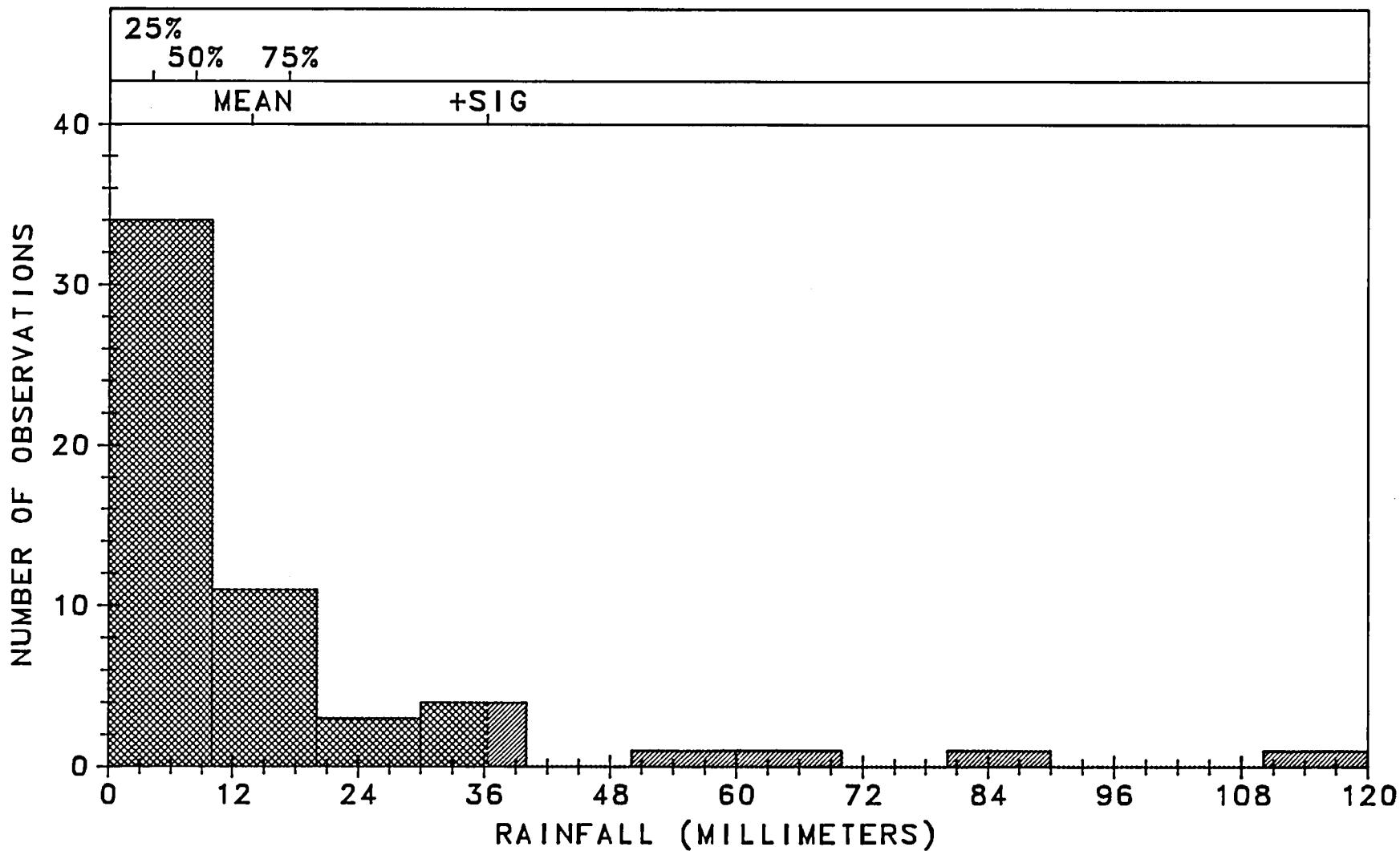


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April 83

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Histogram for April 5, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
56 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING



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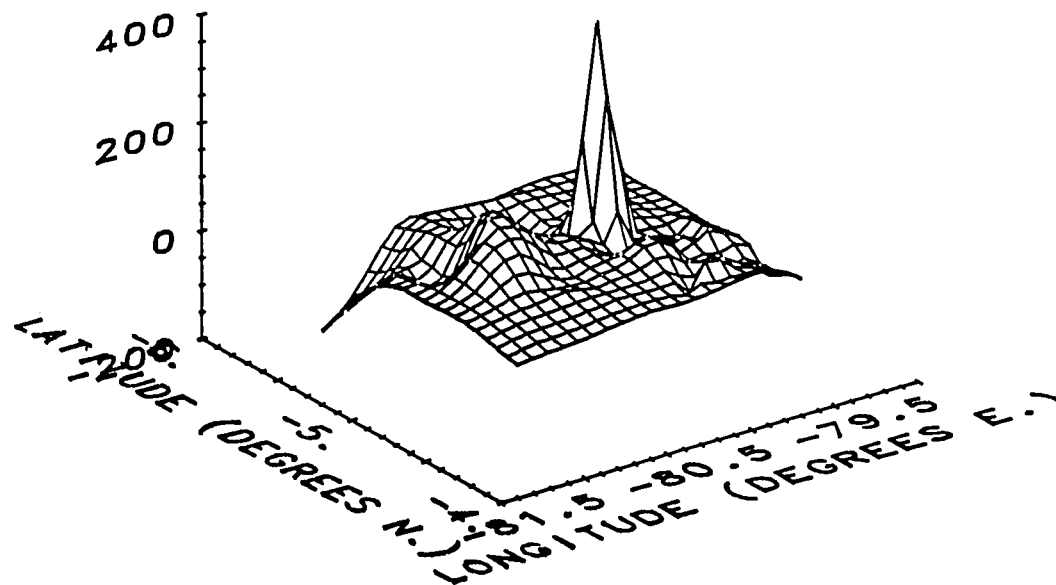
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April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 5, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
1983/04/05 00:00:00 < DATE TIME < 1983/04/05 00:00:00

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SURFACE PLOT OF RAINFALL (MILLIMETERS)

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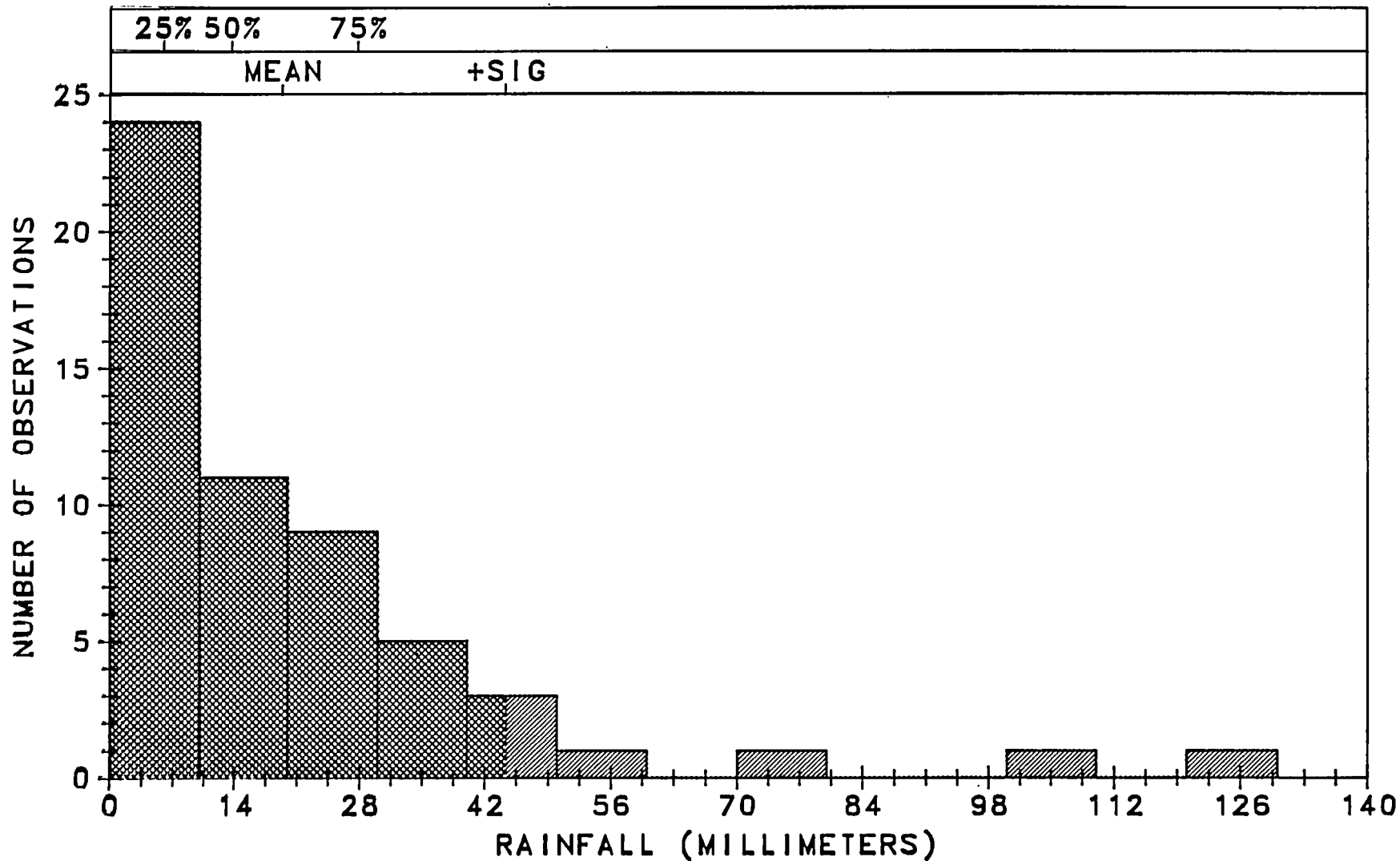
April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Histogram for April 6, 1983

PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA

56 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING



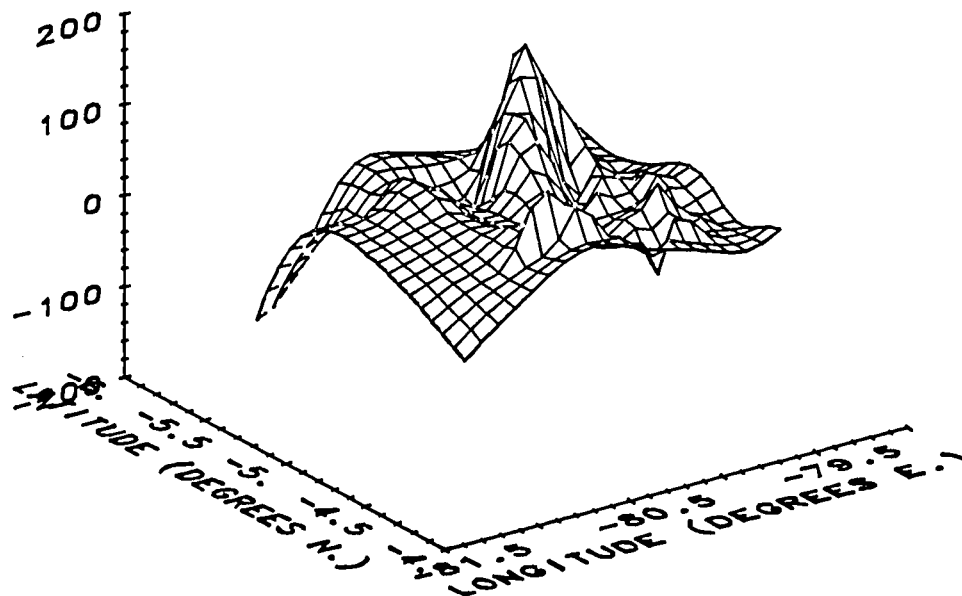
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April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 6, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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STANDARD DEVIATION = 24.93
MEAN VALUE = 19.35



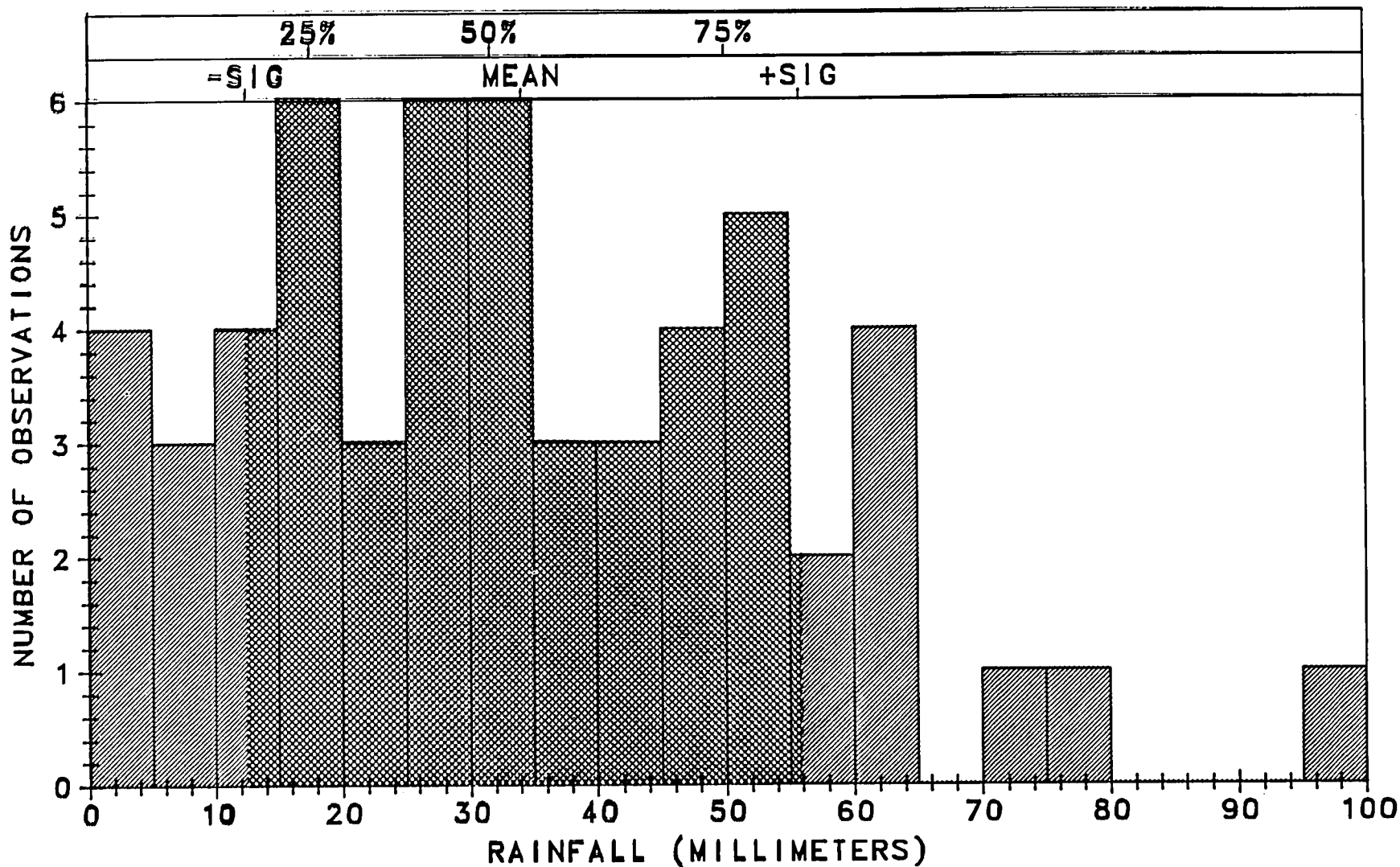
SURFACE PLOT OF RAINFALL (MILLIMETERS)

9830406. < EPOCH (YYMMDD) < 9830406.

Apr 11 83

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Histogram for April 7, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
56 POINTS ARE PLOTTED OUT OF 1680 POSSIBLE POINTS WITH NO AVERAGING



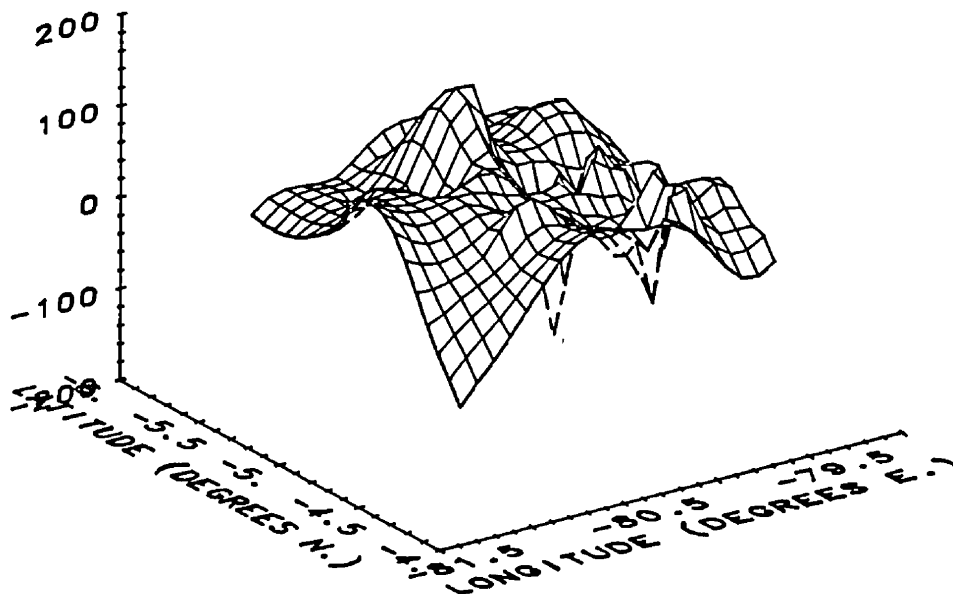
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April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 7, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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STANDARD DEVIATION = 21.67
MEAN VALUE = 34.18



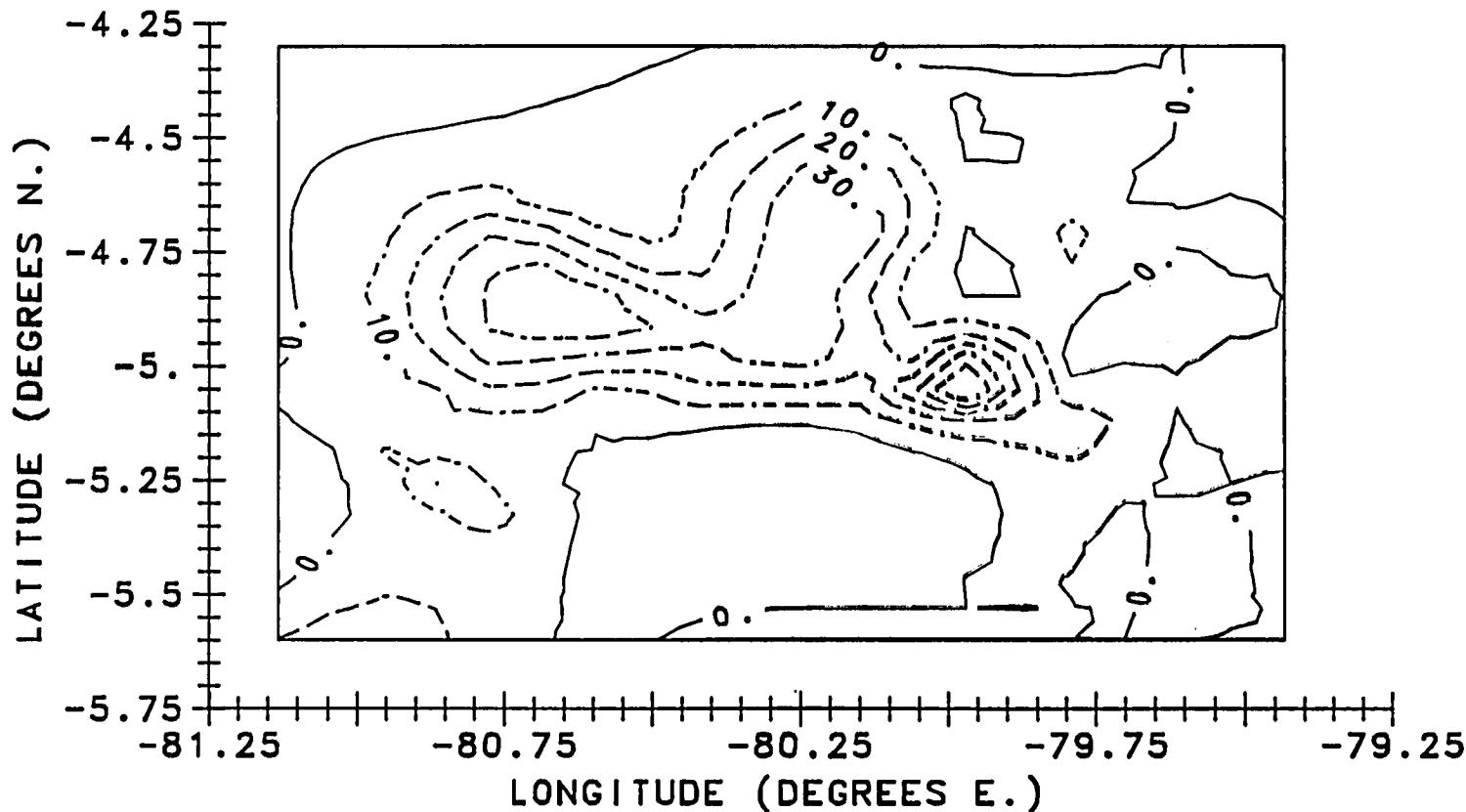
SURFACE PLOT OF RAINFALL (MILLIMETERS)

9830407. < EPOCH (YYMMDD) < 9830407.

Apr 1183

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 3, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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STANDARD DEVIATION = 9.56
MEAN VALUE = 4.32

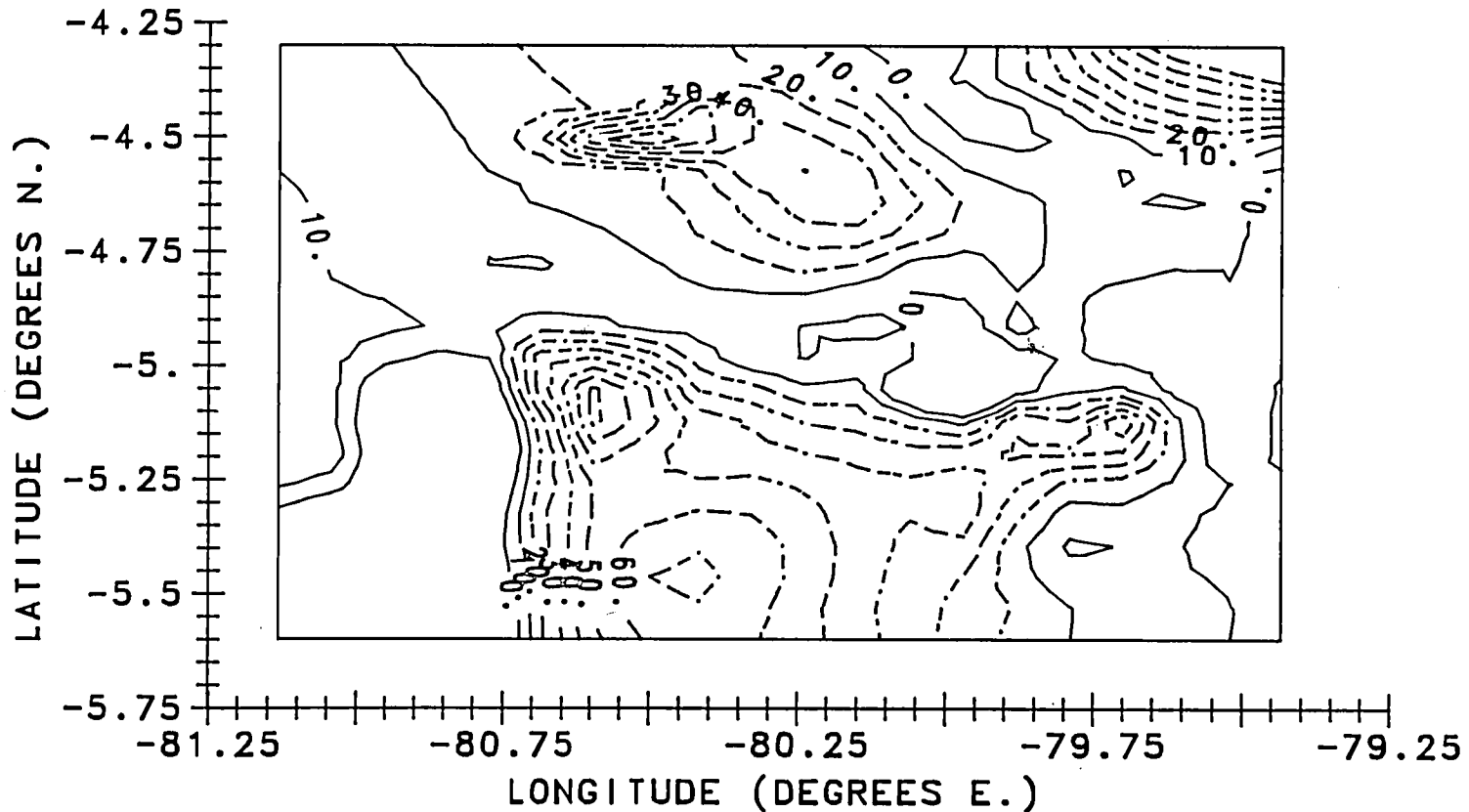
CONTOUR PLOT OF RAINFALL (MILLIMETERS)

9830403. < EPOCH (YYYYMMDD) < 9830403.

April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 4, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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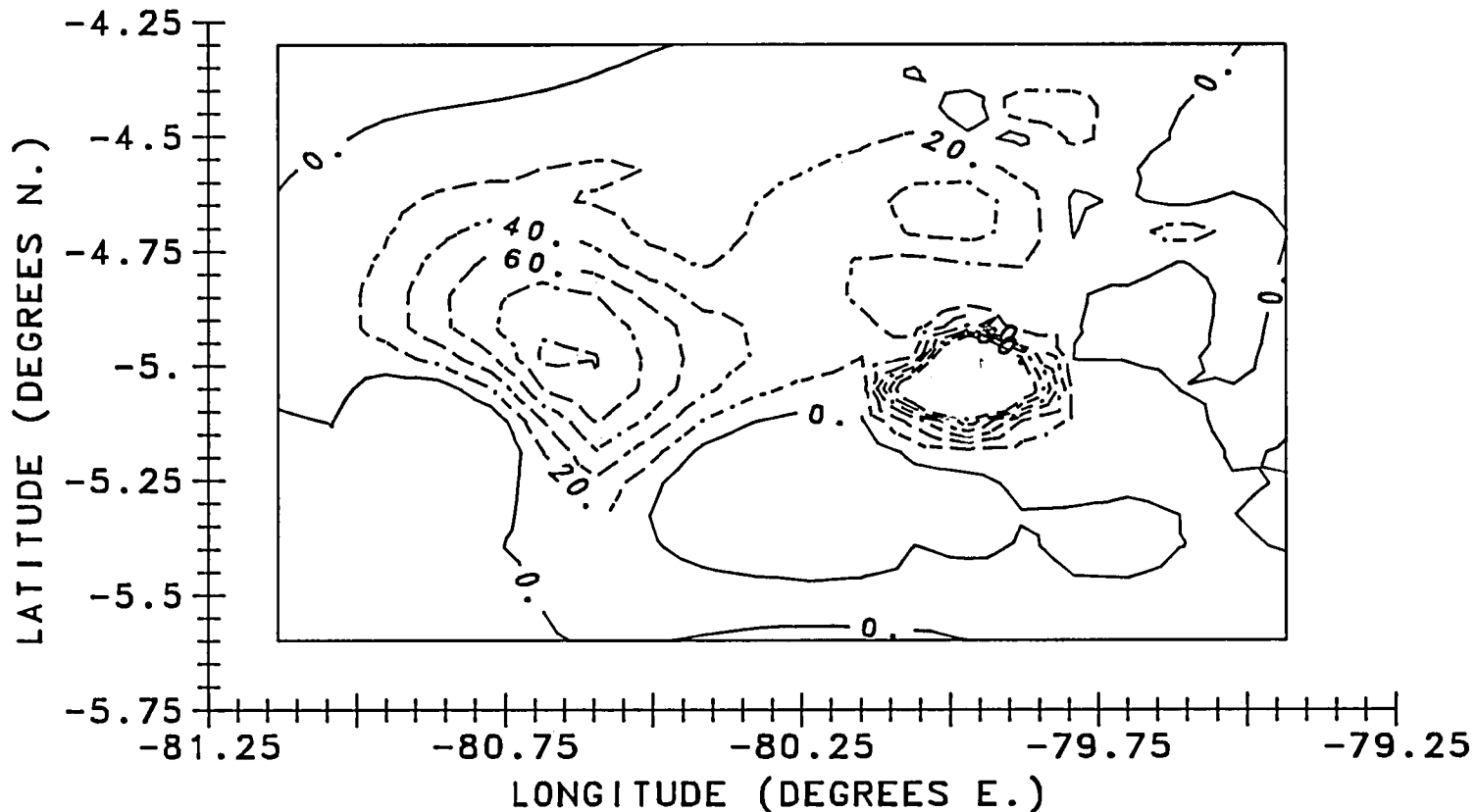
CONTOUR PLOT OF RAINFALL (MILLIMETERS)

9830404. < EPOCH (YYMMDD) < 9830404.

April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 5, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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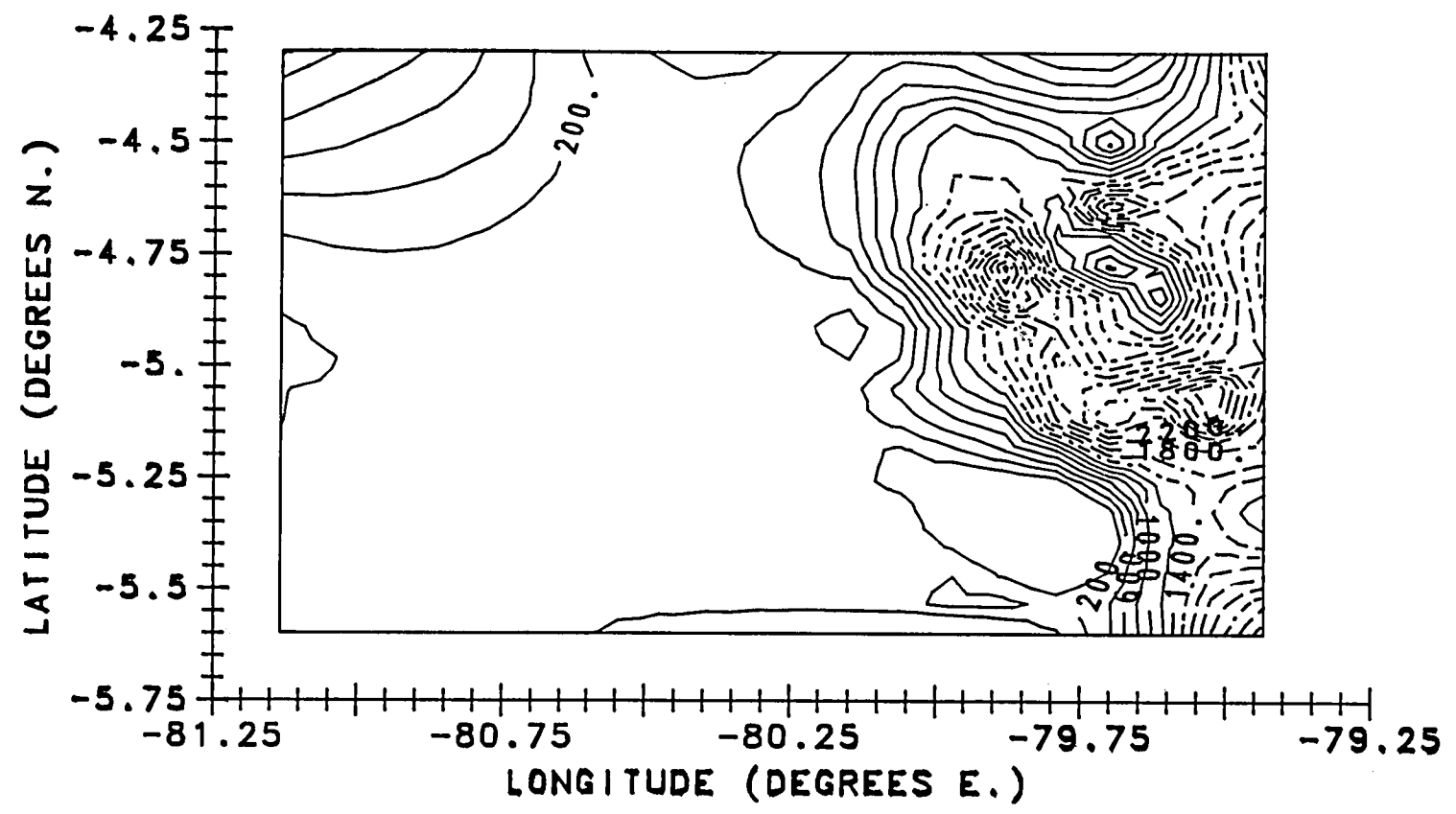
CONTOUR PLOT OF RAINFALL (MILLIMETERS)

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April 1983

PLOTTED BY PCDS ON 17-OCT-85

Relief Map of Rainfall Region
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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STANDARD DEVIATION = 1042.76
MEAN VALUE = 1251.73

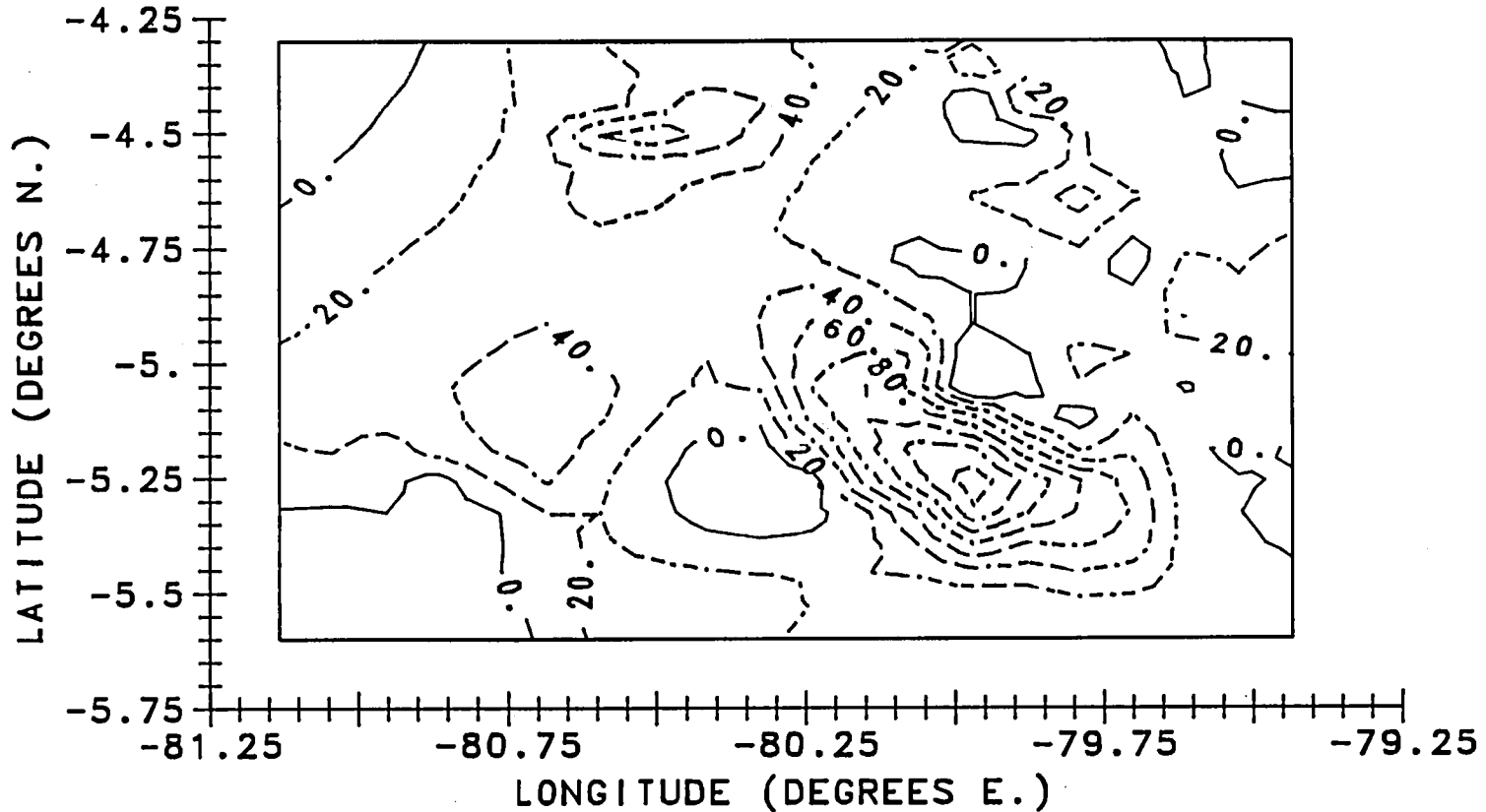
CONTOUR PLOT OF ALTITUDE (METERS)
9830430. < EPOCH (YYMMDD) < 9830430.

4-98

April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 6, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
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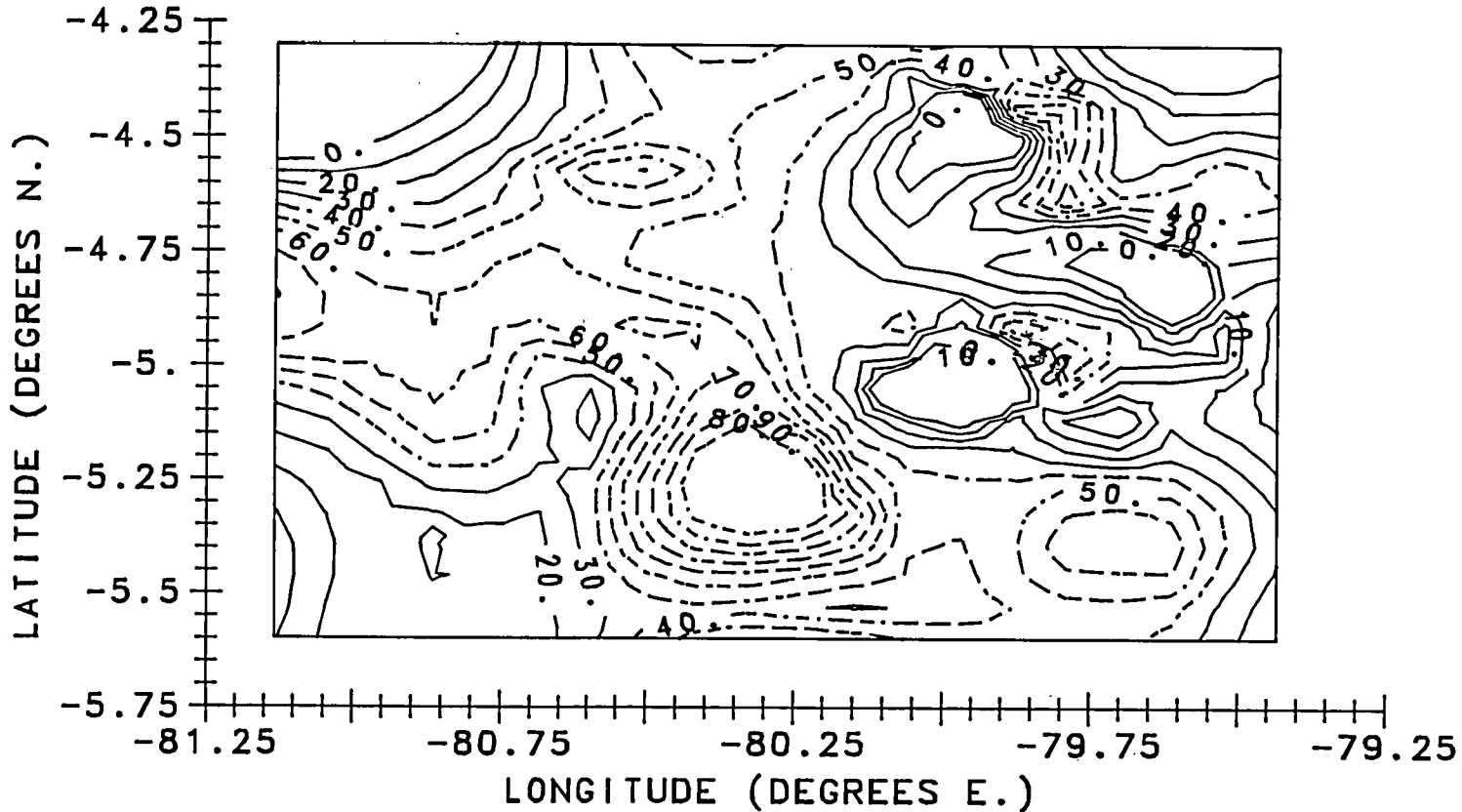
CONTOUR PLOT OF RAINFALL (MILLIMETERS)

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April 1983

PLOTTED BY PCDS ON 16-OCT-85

Rainfall Map for April 7, 1983
PERUVIAN (RAIN GAUGE) STATIONS DAILY RAINFALL DATA
THERE ARE 56 DATA VALUES USED OUT OF 1680 POSSIBLE VALUES
1983/04/07 00:00:00 < DATE TIME < 1983/04/07 00:00:00



STANDARD DEVIATION = 21.67
MEAN VALUE = 34.18

CONTOUR PLOT OF RAINFALL (MILLIMETERS)

9830407. < EPOCH (YYMMDD) < 9830407.

4-100