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Estimates of Monthly Mean Soil Moisture for 1979-1989

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1992

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Monthly mean Ground Wetness:

1979 1
1980 15
1981 29
1982 43
1983 57
1984 71
1985 85
1986 99
1987 113
1988 127
1989 141

11 Year Average:

January 157
February 165
March 173
April 181
May 189
June 197
July 205
August 213
September 221
October 229
November 237
December 245

I. Introduction

As part of a project to produce a multi-year assimilated dataset, the Data Assimilation Office (DAO) in the Goddard Laboratory for Atmospheres has made extensive modifications to the existing general circulation model (the Goddard Earth Observing System Model, GEOS-1). An important aspect of the modifications was the development of improved lower boundary conditions. In particular, GEOS-1 does not have a coupled land surface model and requires soil moisture to be specified. The soil moisture, however, is not a quantity readily derivable from conventional observations without adequate surface radiation measurements.

Thornthwaite (1948) proposed a procedure to compute soil moisture from observed monthly mean precipitation and estimated potential evapotranspiration using surface air temperature. The procedure has been tested in many field studies (Mintz and Serafini, 1984 and references therein) and shown to give a reasonable approximation to local measurements of the soil moisture and evapotranspiration. Mintz and Serafini adopted this procedure to generate gridded climatological soil moisture distributions which have been used as a part of the climatological GCM boundary conditions. In this study, we have used the same procedure with some modification to generate soil moisture fields for each month of the period 1979 - 1989.

Section II describes the surface station climatological dataset, Section III describes the procedure to obtain soil moisture estimates, and Section IV lists the global quantities included in this document.

II. Data

A copy of the world monthly surface station climatology dataset was obtained from the National Center for Atmospheric Research (NCAR). The dataset includes monthly mean sea level pressure, station pressure, surface air temperature and monthly total precipitation at surface stations from mid-1700's up to 1989. The number of station reports varies from year to year, but is on the order of 2500 in more recent periods. Most of the data included in this dataset were obtained from the National Climatic Data Center (NCDC), Asheville, North Carolina. However, several individuals contributed towards upgrading and completing the dataset. These include Sharon Nicholson (Florida State University) for the African precipitation data and Dennis Shea (NCAR) for data obtained directly from various countries. A detailed description of the dataset and data sources can be found in Spangler and Jenne (1990).

For the present work, a subset of the monthly mean surface air temperature and the monthly total precipitation was created for the years 1979 - 1989. For any year, stations with more than 6 months of missing data were not used. The number of stations included in the soil moisture computation is listed in Table 1. An example of data coverage is given in Fig. 1; the crosses indicate the location of stations with more than 6 months of data in 1985.

III. Soil Moisture Estimate

Mintz and Serafini (1984) derived a procedure to compute soil moisture based on the method proposed by Thornthwaite (1948). An equation for the soil moisture, w, is written as,

$$\frac{\partial w}{\partial t} = P - E , \quad w_{max} = w^* , \tag{1}$$

where

$$E = E_P \times \beta(w, w^*) . \tag{2}$$

Here, P denotes the precipitation rate, E the rate of evapotranspiration, w^* the maximum soil moisture available for evapotranspiration which is defined as the difference between the moisture storage capacity of soil and soil moisture at the wilting point of plants, E_P the potential evapotranspiration, and β the evapotranspiration coefficient. The magnitude of w^* is fixed at 150 mm as in Mintz and Serafini, and any amount greater than w^* is treated as runoff.

Following Thornthwaite (1948), the potential evapotranspiration for a month is estimated as a function of the monthly mean surface air temperature and duration of daylight,

$$E_P = \begin{cases} 0 , & T_A < 0^\circ c \\ 16L(10T_A / I)^a , & 0 \le T_A \le 26.5^\circ c \\ -415.85 + 32.35T_A - 0.43T_A^2 , & T_A > 26.5^\circ c \end{cases} \tag{3}$$

where

$$I = \sum_{m=1}^{12} (T_{Am} / 5)^{1.514} ,$$

$$a = (6.75 \times 10^{-7}\ I^3) - (7.71 \times 10^{-5}\ I^2) + (1.79 \times 10^{-2}\ I) + 0.49 ,$$

and

$$L = (D/30)(h/12) .$$

Here D is the number of days in the month, h the number of hours of daylight, and T_A the monthly mean surface air temperature in each month of the year.

The evapotranspiration coefficient, β , is given as

$$\beta = 1 - \exp[-6.8(w/w^*)] . \tag{4}$$

The above relationship is based on the analysis of field measurements by Nappo (1975) as adopted by Mintz and Serafini (1984), and represents the curve of best fit to (E/E_P) plotted against the volumetric soil moisture content.

Although the above procedure to estimate the evapotranspiration is somewhat crude, it is shown to give reasonable results and has been used extensively (Mintz and Serafini, 1984 and references therein). In some cases, however, it is known to strongly underestimate the potential evapotranspiration (Sellers, 1965).

Mintz and Serafini (1984) developed an iterative procedure to solve (1) for w and E based on climatological monthly mean precipitation and surface air temperature. In the present computation, an analytic solution was obtained after substituting (2) and (4) into (1). The solution is given as:

$$w = -\frac{1}{\alpha}\ln\left[\frac{(P - E_P)\exp\{-\alpha(P - E_P)t\}}{(P - E_P)\exp(\alpha w_0) + E_P[1 - \exp\{-\alpha(P - E_P)t\}]}\right] , \tag{5}$$

where

$$\alpha = 6.8/w^* .$$

Here, w_0 is the initial soil moisture and time t is elapsed time. For each month, the soil moisture, w, was computed daily with an averaged precipitation rate and potential evapotranspiration based on the monthly means. The monthly mean soil moisture was obtained by averaging the daily values for the month and the evapotranspiration E was estimated from (2). As in Mintz and Serafini, runoff was accounted for by not allowing w to exceed w^*.

It should be noted here that the above procedure does not account for frozen ground and ice formation. Since there is no evapotranspiration when the air temperature is below the freezing point, the precipitation is simply accumulated as soil moisture. This might overestimate the soil moisture during the winter season.

The soil moisture was computed at each station for the period of 1979 - 1989 in one year segments. For each year, the solution was allowed two months of 'spin-up' period by starting the integration at the beginning of November of the previous year as initial conditions. For convenience, November climatological soil moisture values of Mintz and Serafini were used as the initial conditions, since several experiments with the initial conditions indicated that the results were independent of the initial conditions after two months of integration. The procedure was also reinitialized with climatological soil moisture values after periods of missing data.

In order to generate data suitable for GCM boundary conditions, the station values of soil moisture were interpolated to a 2x2.5 degree latitude/longitude grid. The interpolation was performed by averaging station values within a 300 km radius of each grid point. The averaging weights are proportional to the inverse of the square of the distance of stations from the grid point. The value at a grid point with no station data within the 300 km radius was denoted as undefined.

IV. List of Quantities

The following is a list of global maps included in this report.

1) Monthly mean ground wetness defined as the ratio of soil moisture to the maximum available moisture (w/w^*, $w^* = 150$ mm) for the period 1979 - 1989.

2) 11-year average of monthly mean ground wetness, precipitation, surface air temperature, evapotranspiration and potential evapotranspiraton. Also included is the standard deviation of the monthly mean ground wetness based on the 11 years of data.

For the plots, precipitation, surface air temperature, evapotranspiration and potential evapotranspiration were interpolated in the same manner as described in Section III. On the maps, areas with undefined values are indicated by hatching and the interpretation for different shadings is included where it is needed. For the standard deviation of ground wetness, areas with values greater than 0.05 are lightly shaded.

The datasets described in this document and the gridded monthly mean surface air temperature, monthly total precipitation, potential evapotranspiration and evapotranspiration for the period 1979 - 1989 are available to the general community. For further information on these datasets, contact

Head, Data Assimilation Office
Code 910.3
NASA/Goddard Space Flight Center
Greenbelt, MD 20771 .

Acknowledgements

We wish to thank Greg Walker and Yogesh Sud for their help and valuable discussions on adopting the Mintz and Serafini procedure, and Laura Rumburg for her assistance in graphics.

References

Mintz, Y. and Y. Serafini, 1984: Global fields of monthly normal soil moisture as derived from observed precipitation and an estimated potential evapotranspiration. Final scientific report under NASA grant NAS 5-26, Part V, Dept. of Meteorology, University of Maryland, College Park, MD

Nappo, C. J., 1975: Parameterization of surface moisture and evaporation rate in a planetary boundary layer model. Jour. of Applied Meteor., 14, 289 - 296.

Sellers, W. D., 1965: Physical Climatology, The University of Chicago Press, 272 pp.

Spangler, W. M. L. and R. L. Jenne, 1990, World monthly surface station climatology. National Center for Atmospheric Research, Boulder, CO.

Thornthwaite, C. W., 1948: An approach toward a rational classification of climate. Geographical Review, 38, 55-94.

Table 1. Number of surface stations included for soil moisture estimates

Year	No. of stations
1979	1351
1980	1345
1981	1261
1982	1215
1983	1320
1984	1254
1985	1151
1986	1127
1987	1369
1988	1426
1989	1343

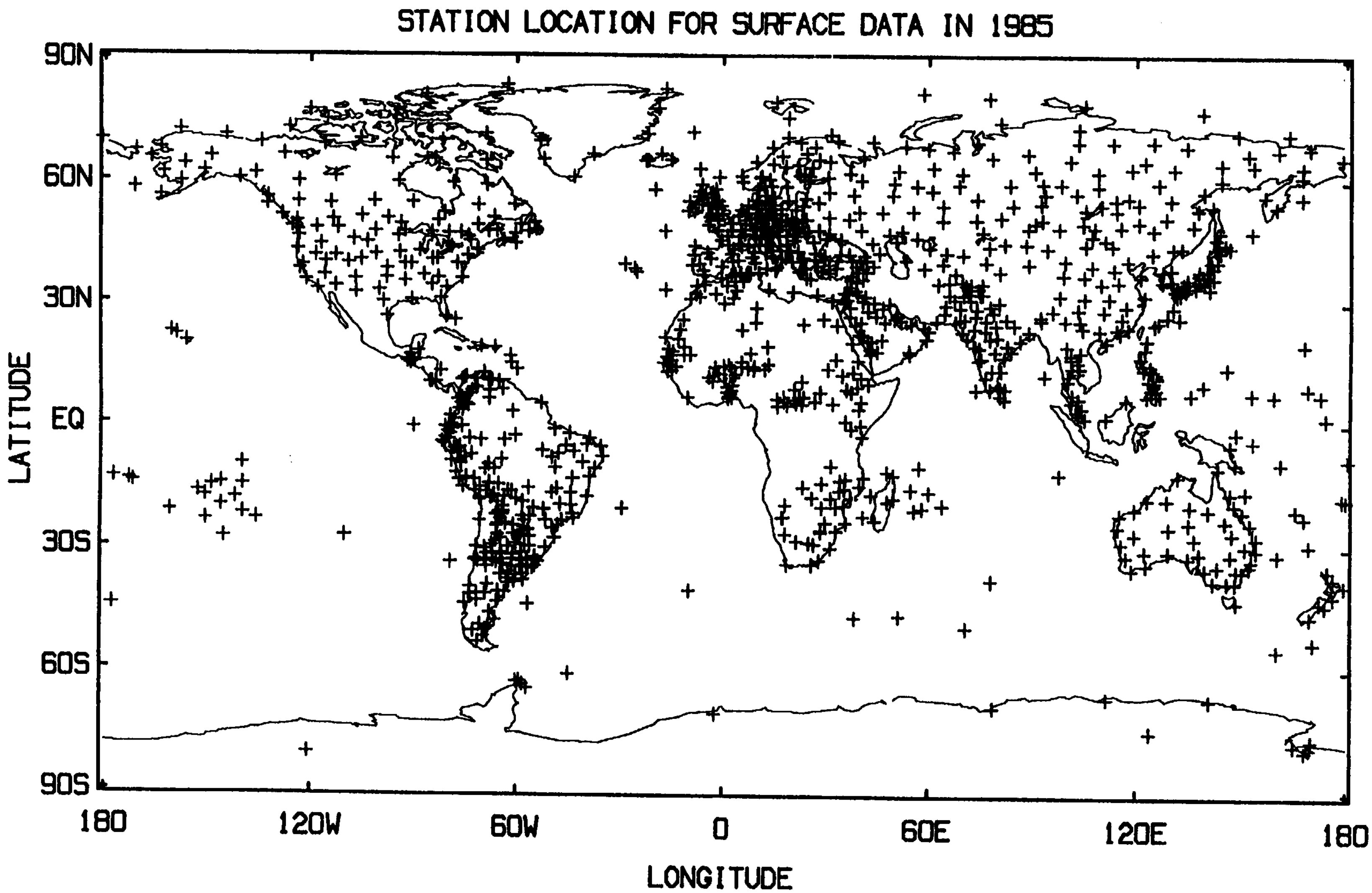
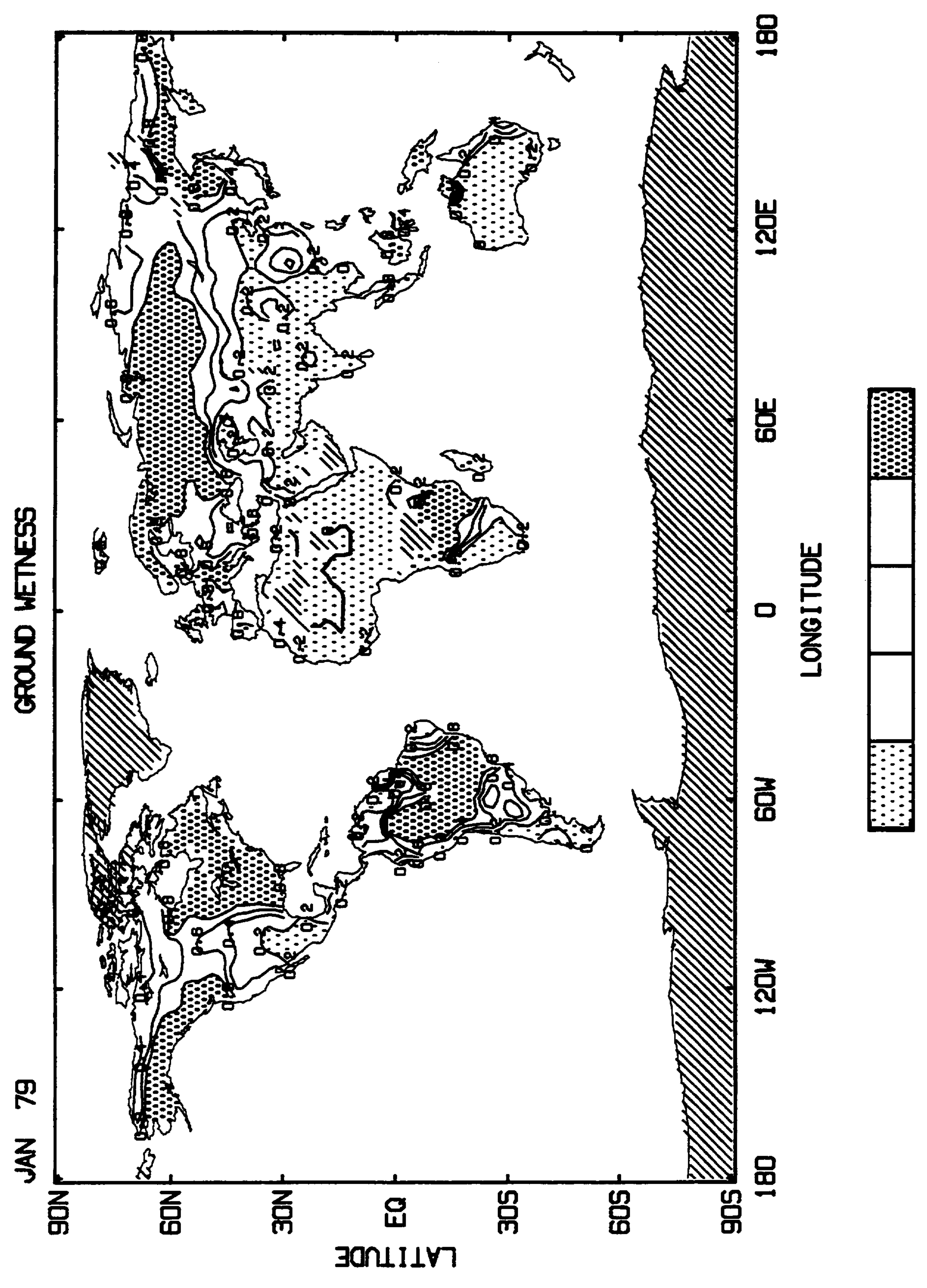


Fig. 1: An example of the data coverage for soil moisture calculation. The crosses indicate the location of stations with surface data for more than 6 months in 1985.

1979



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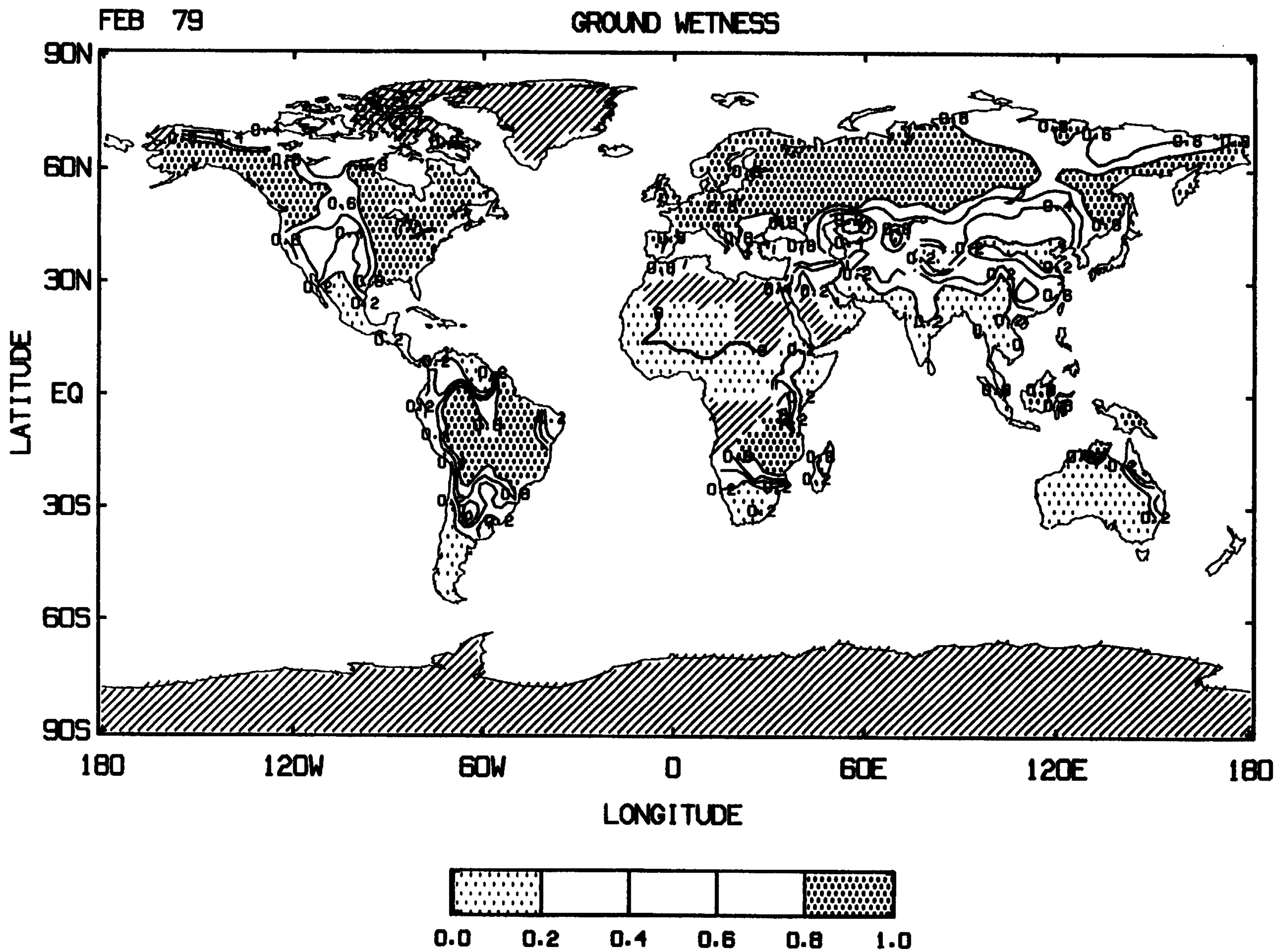
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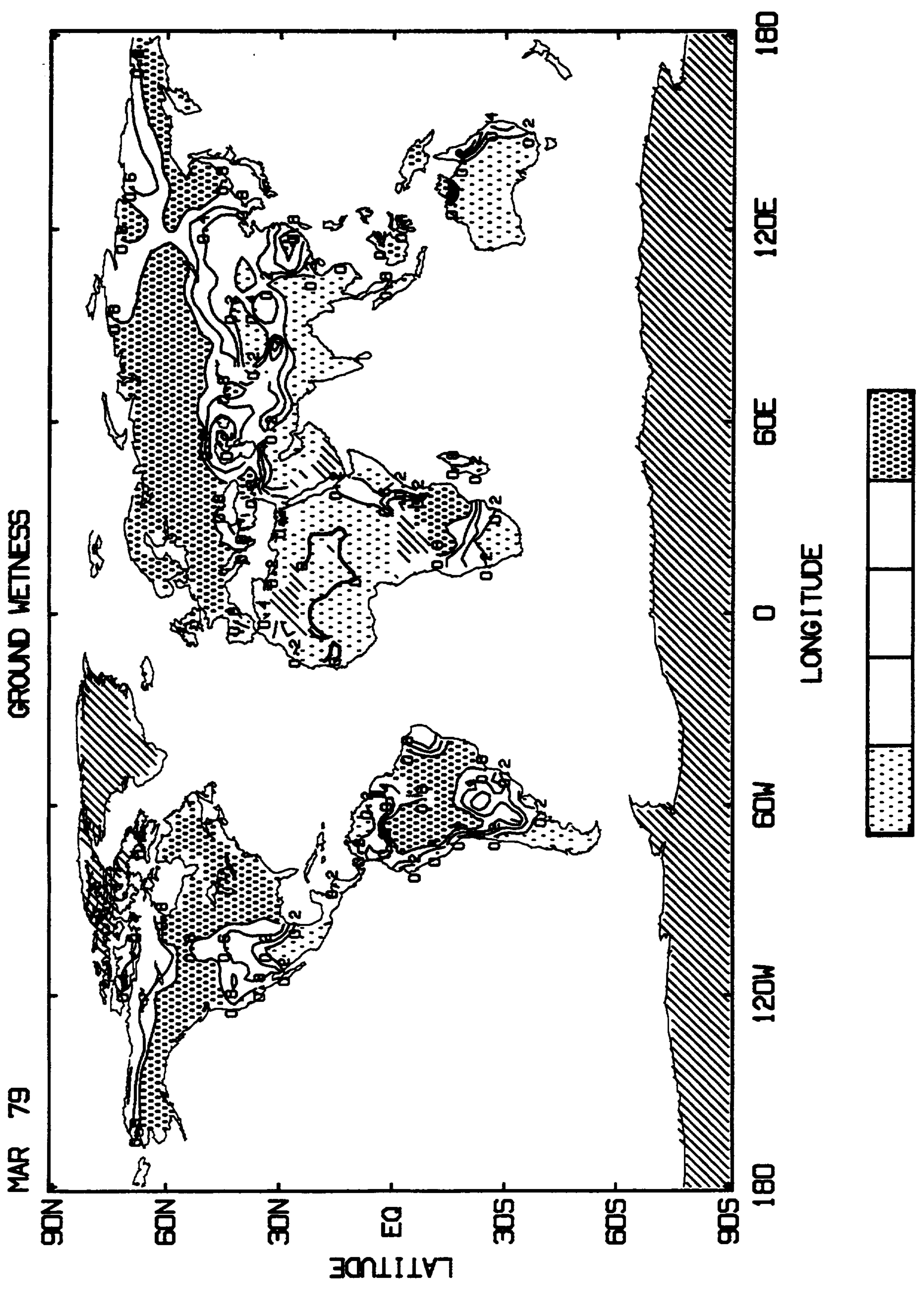
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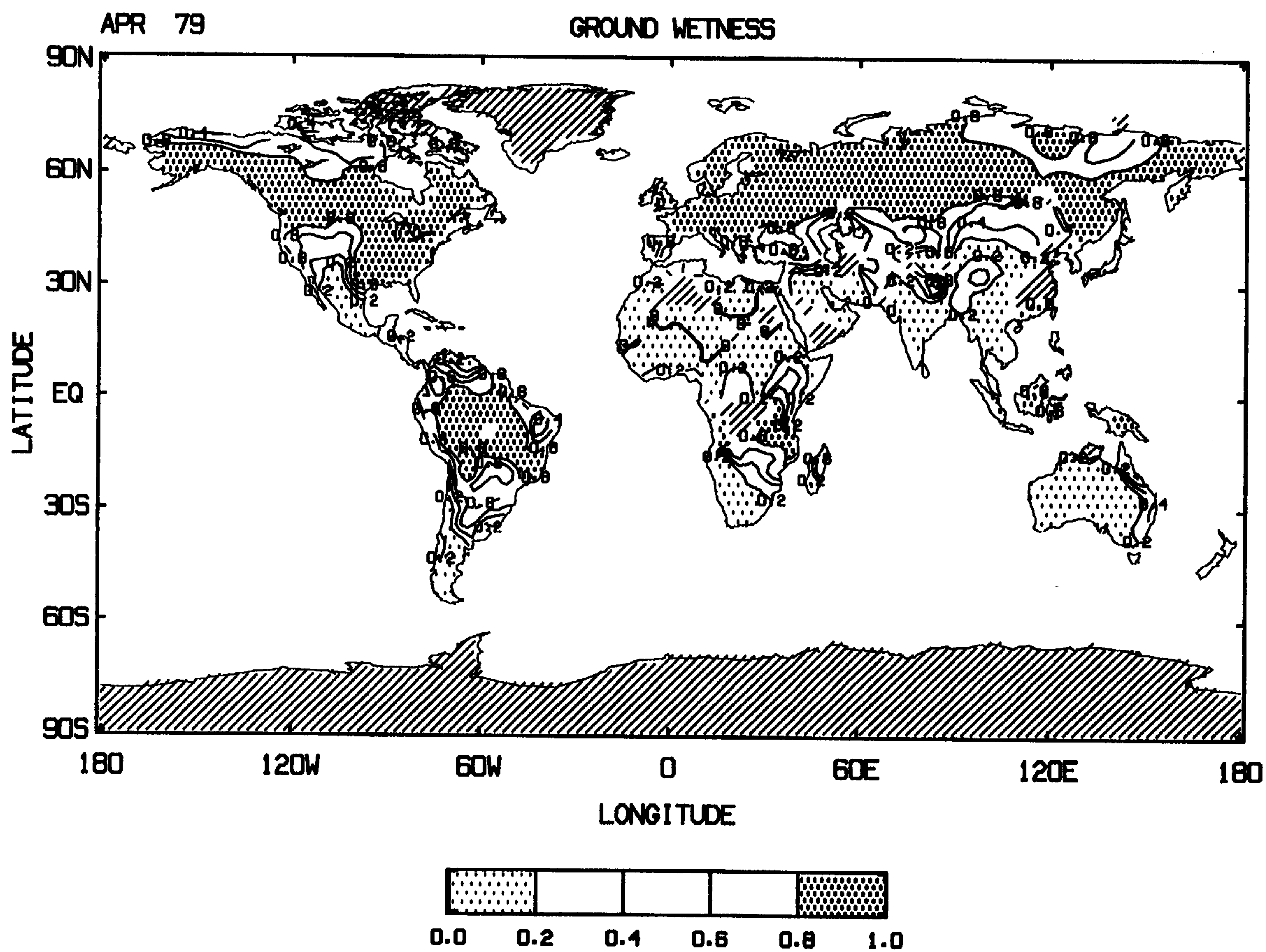
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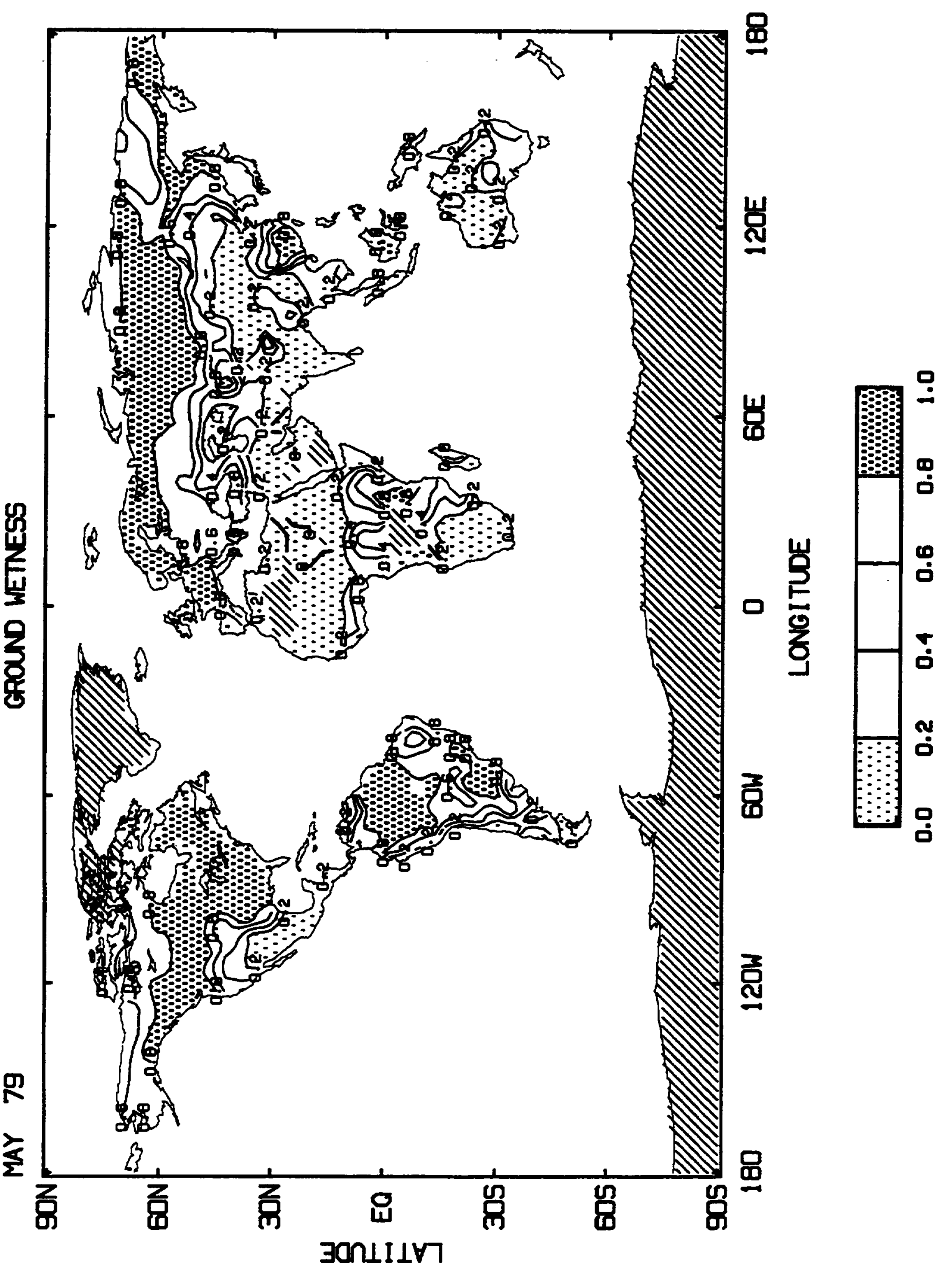

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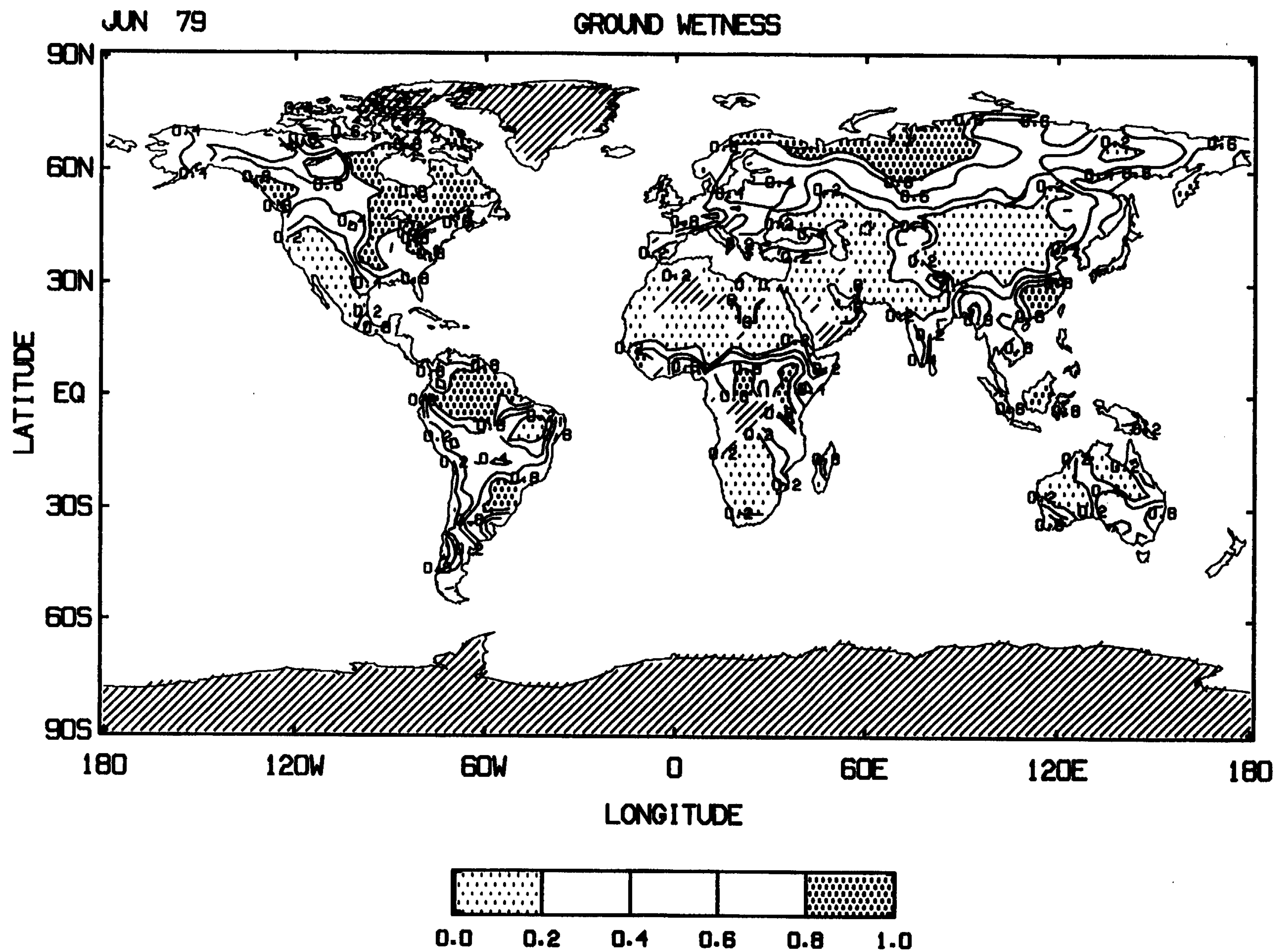

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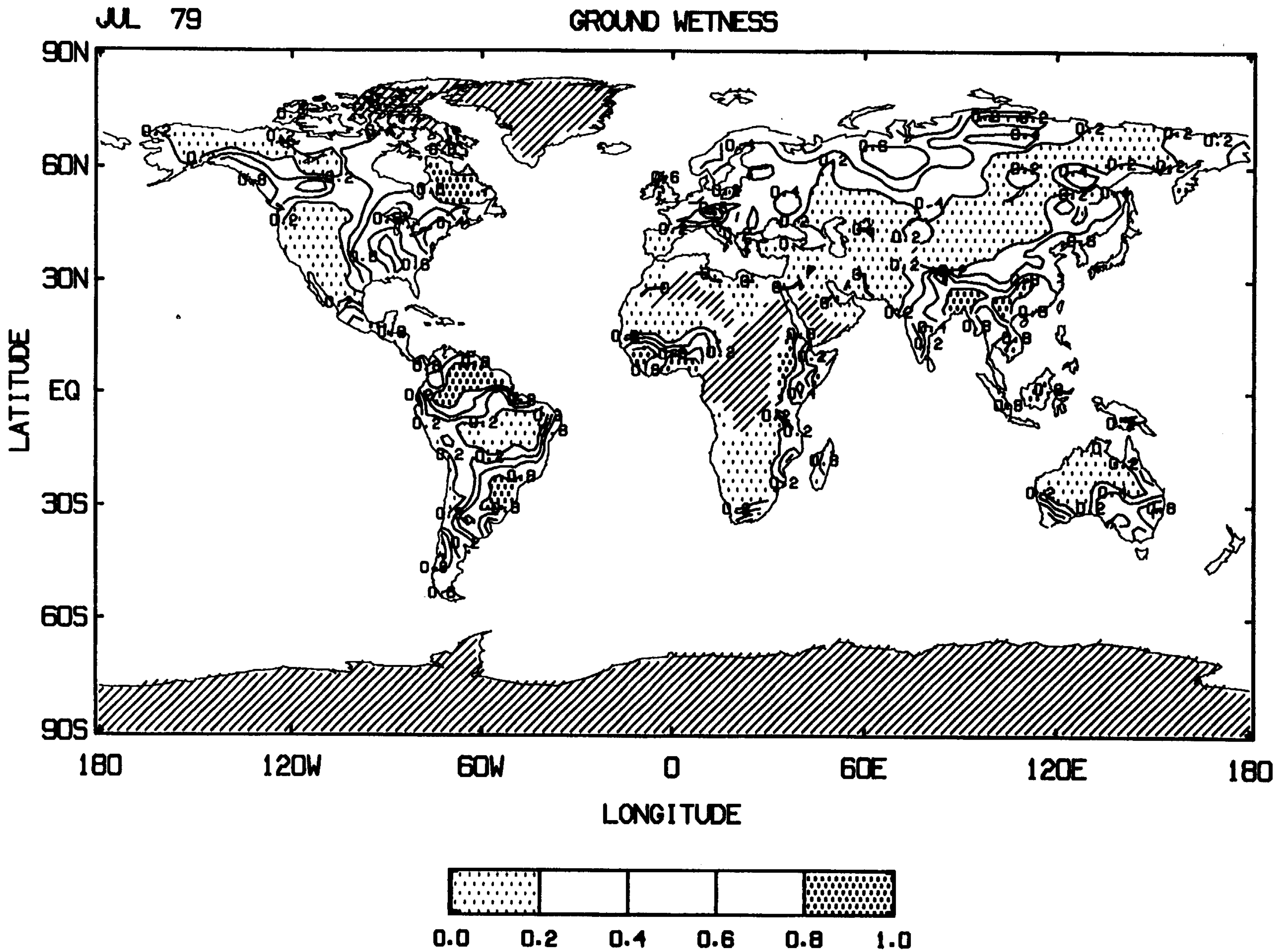
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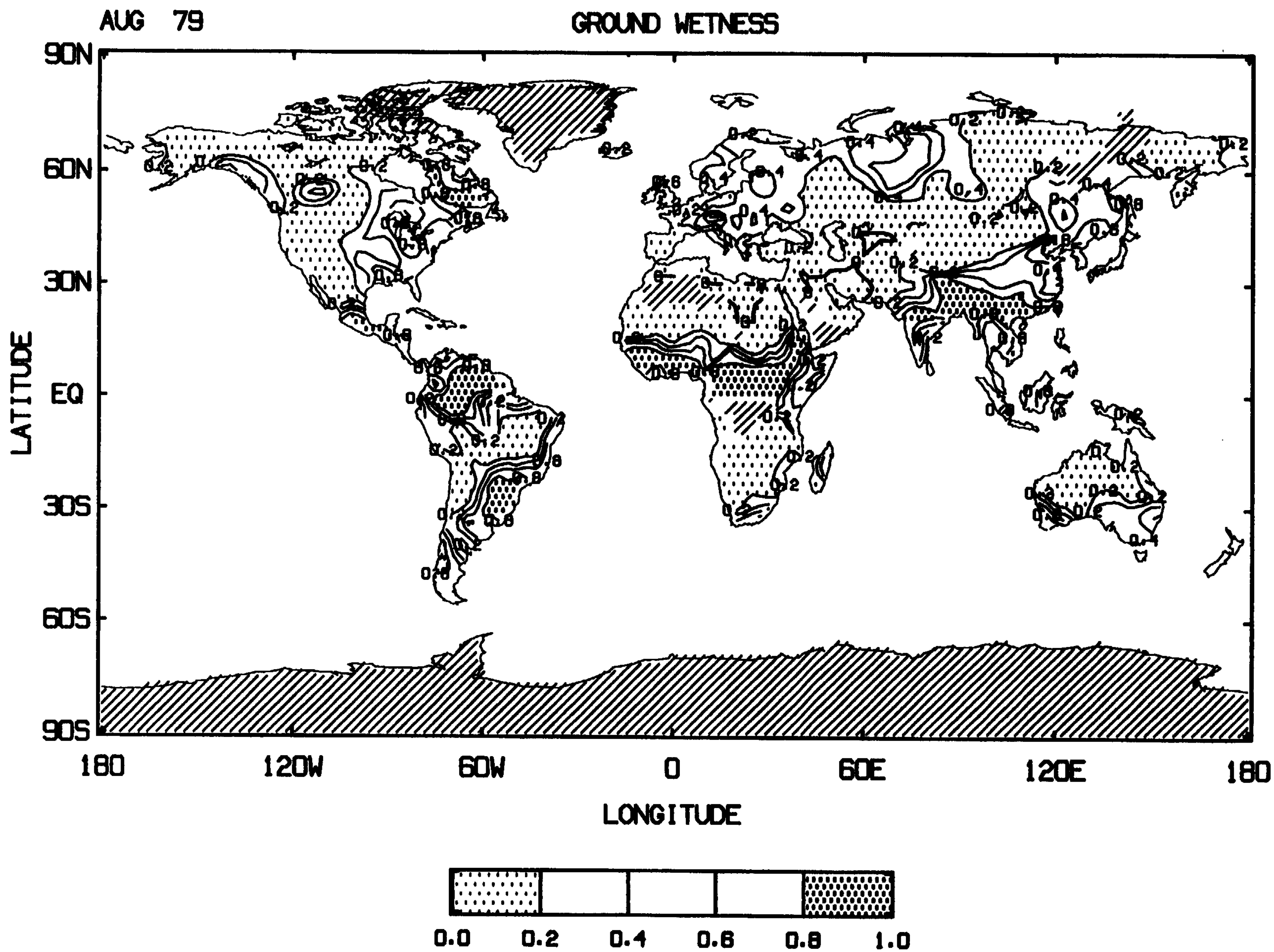
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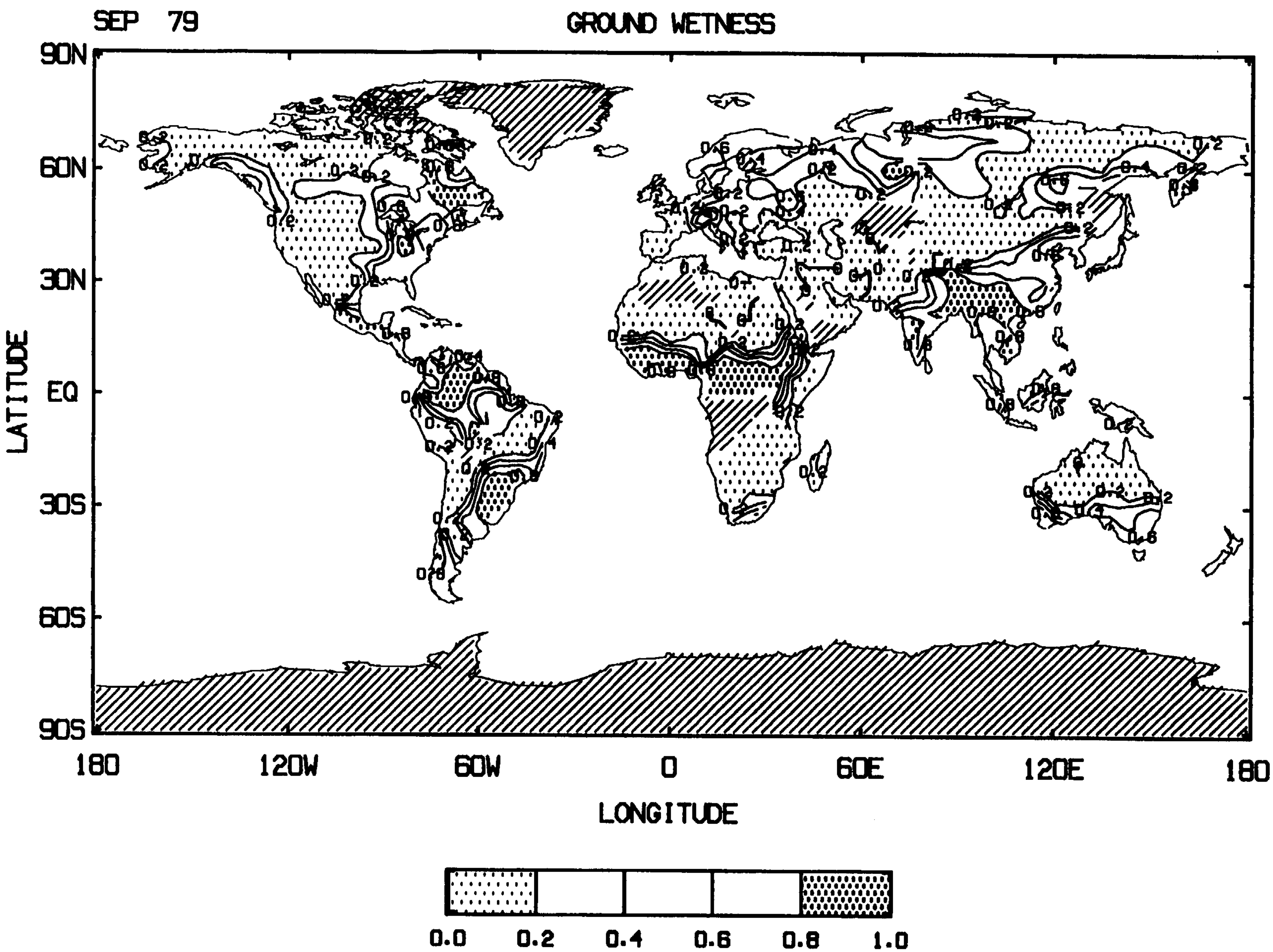
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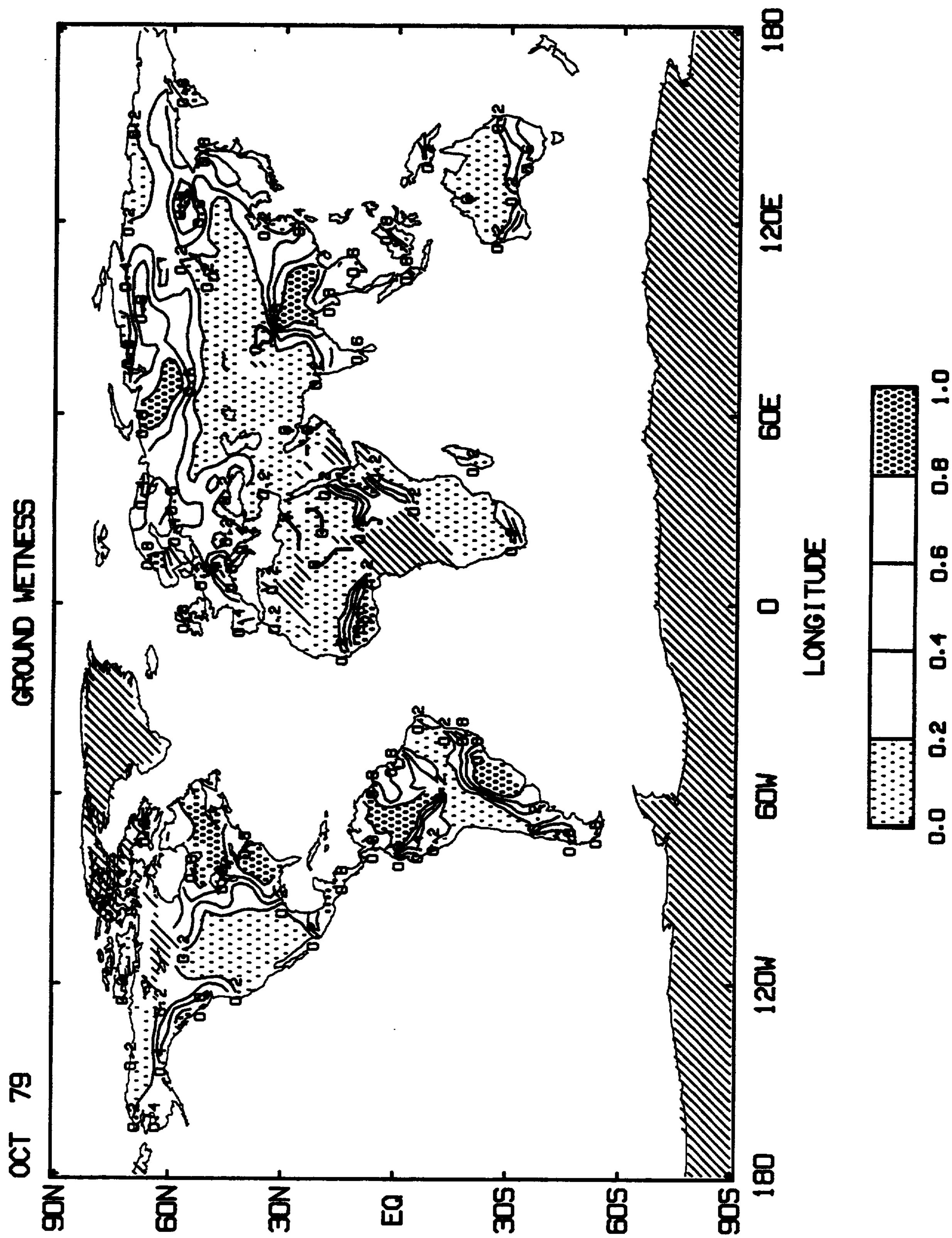

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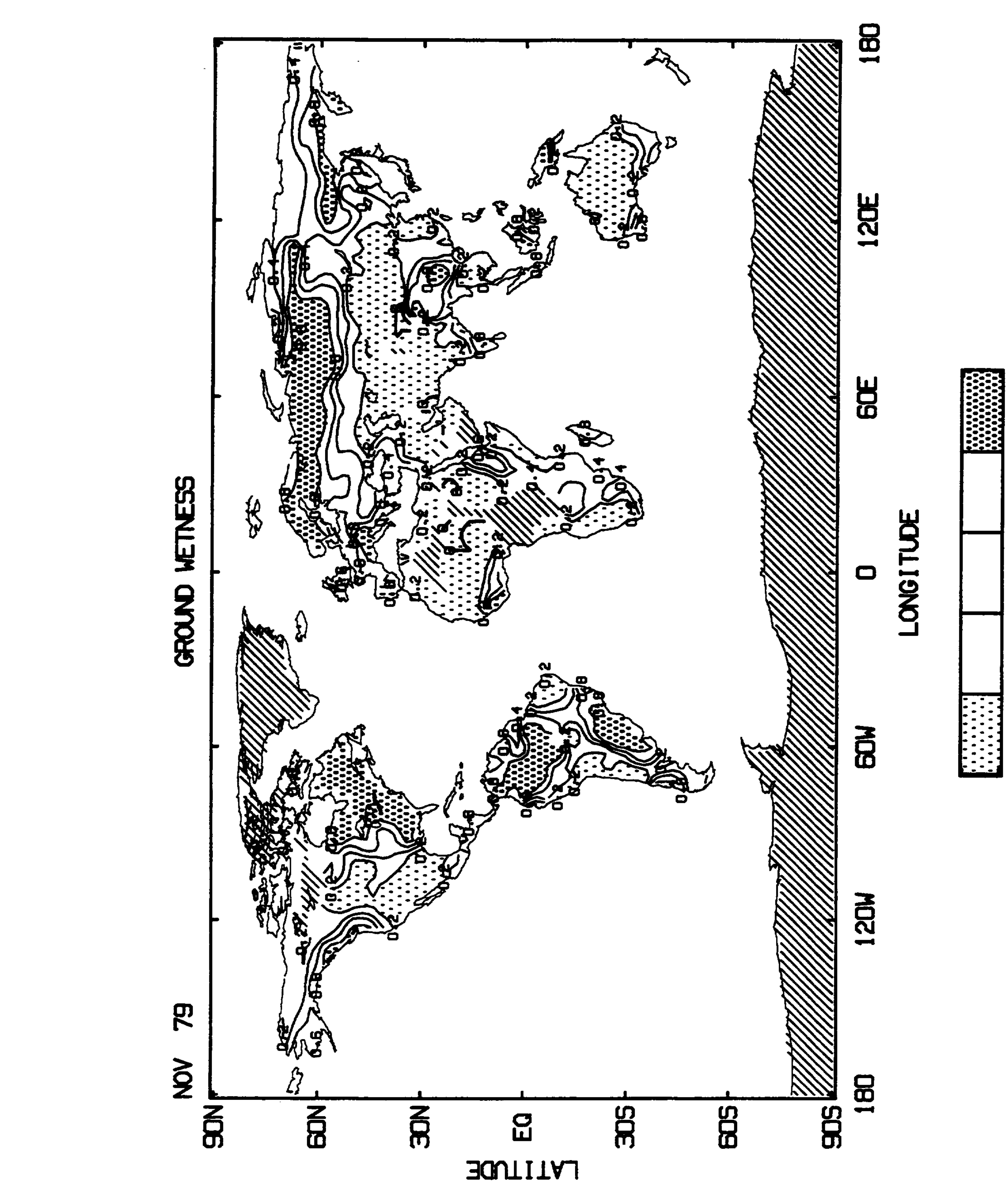
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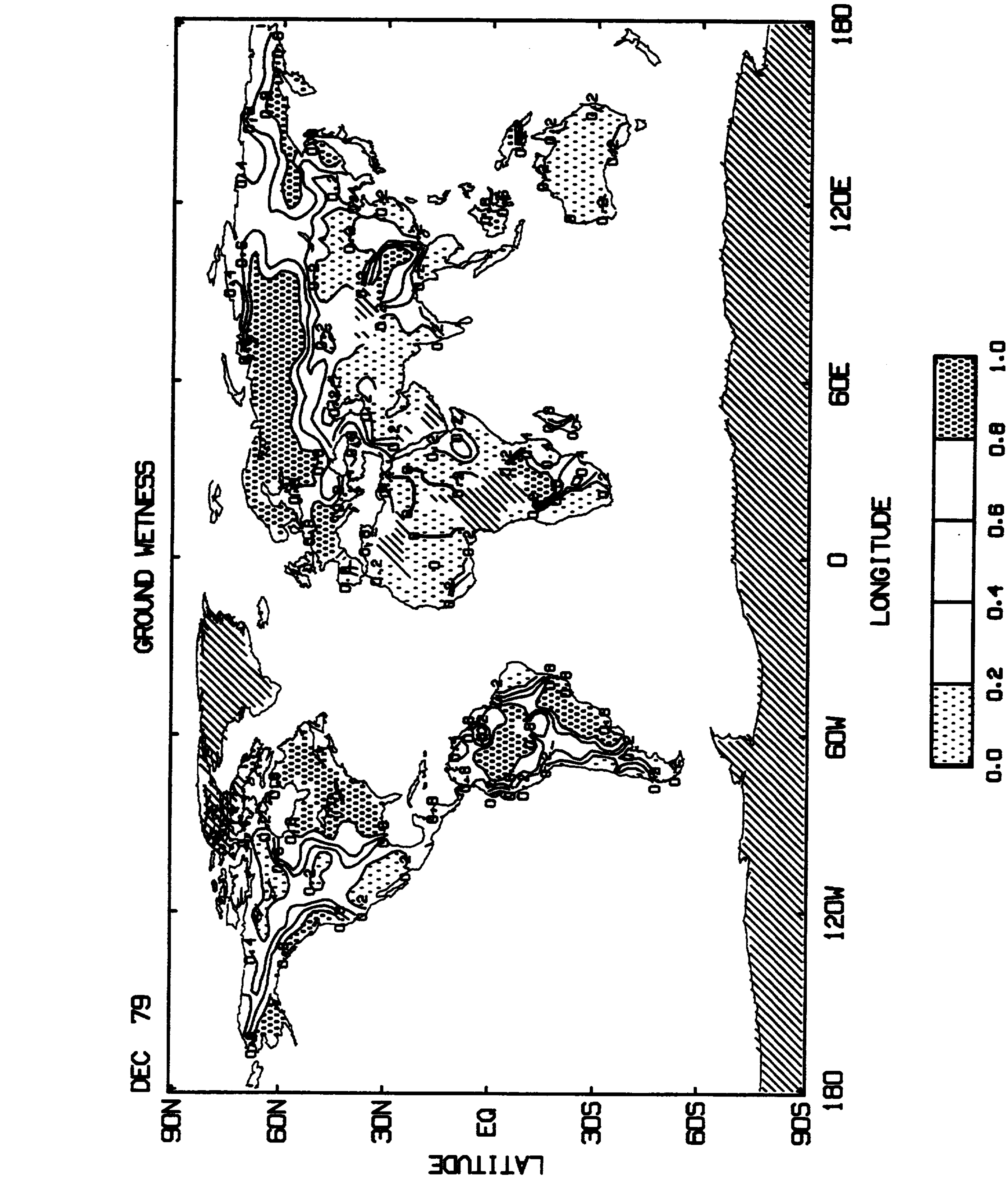
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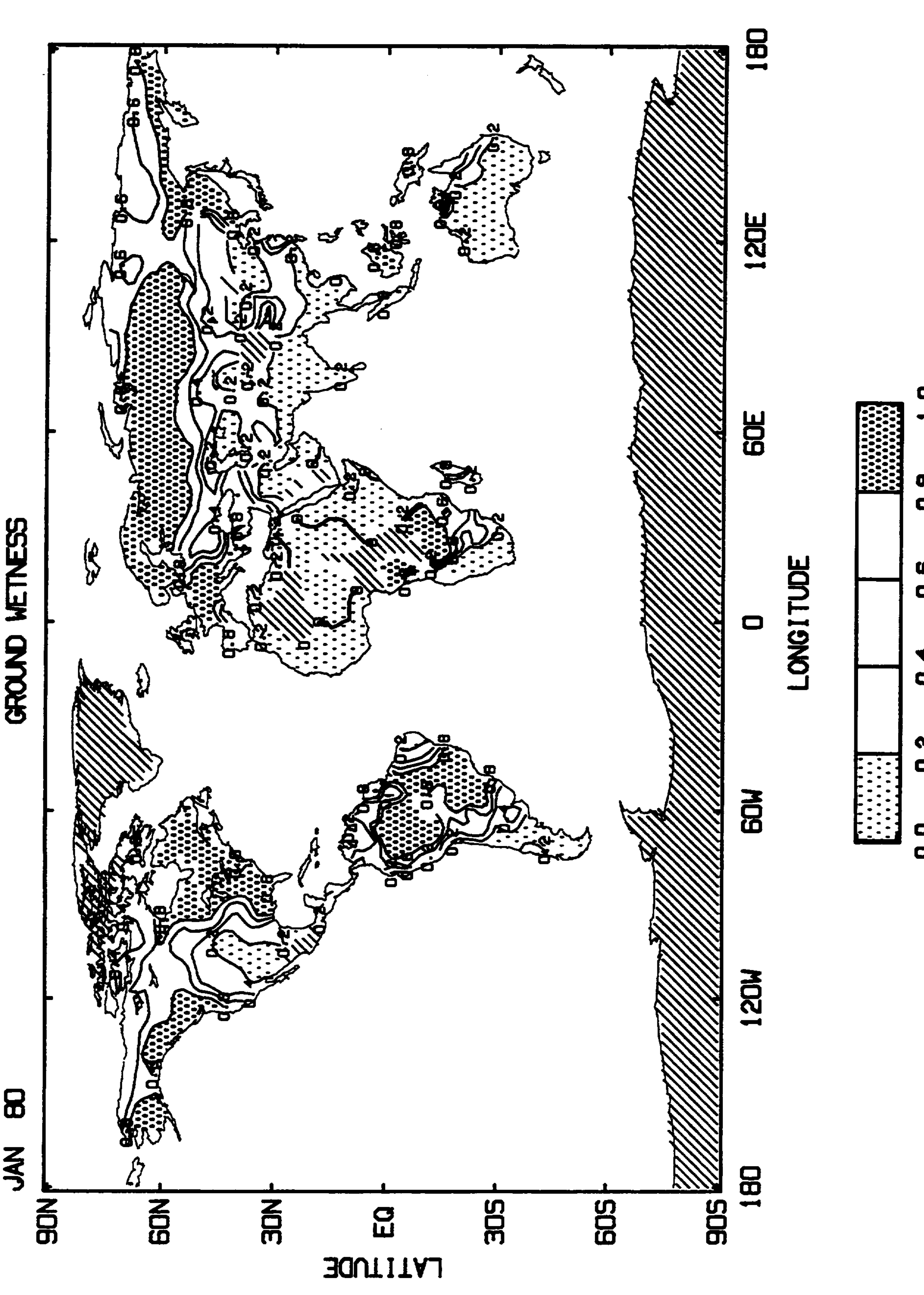

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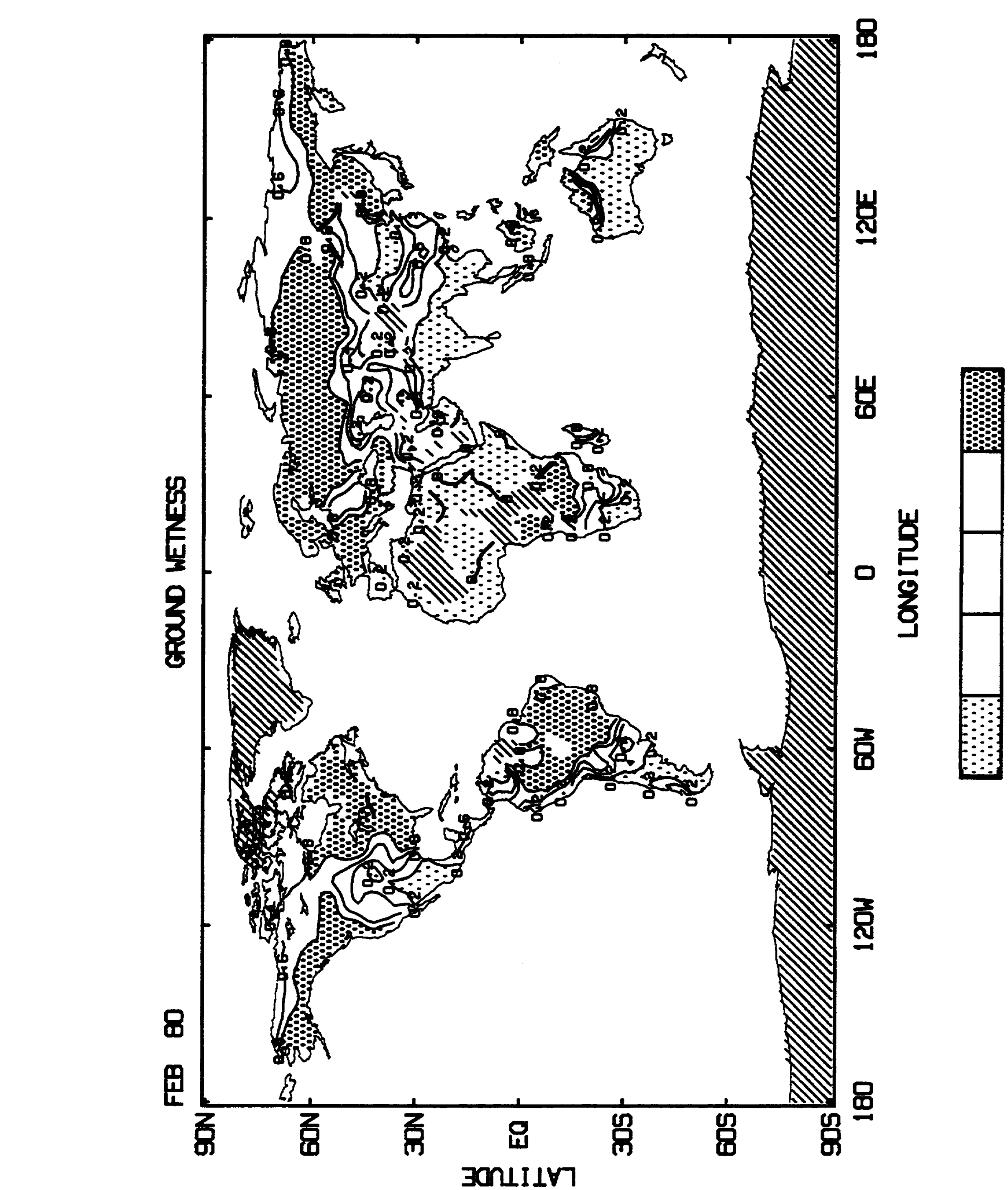

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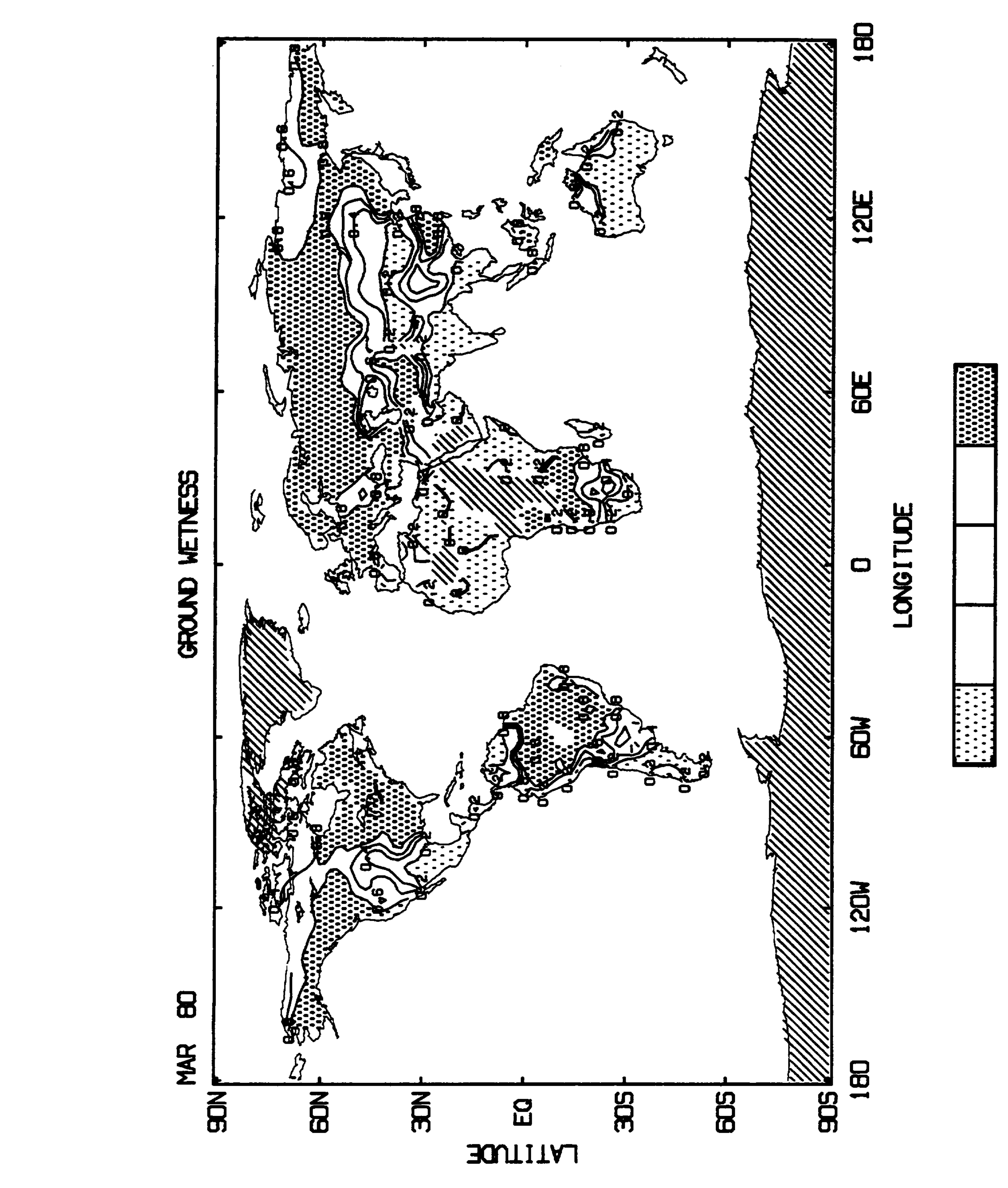
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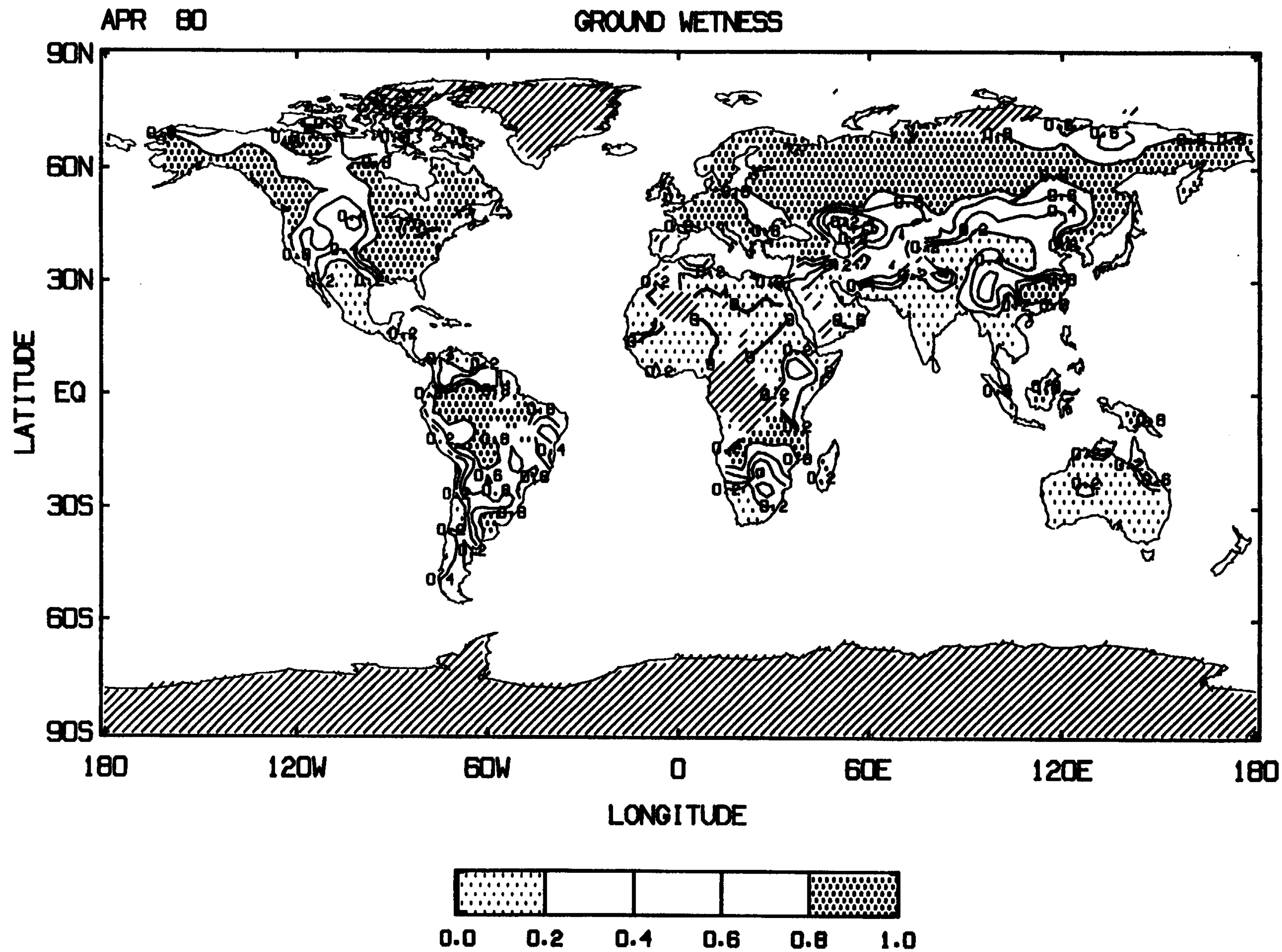

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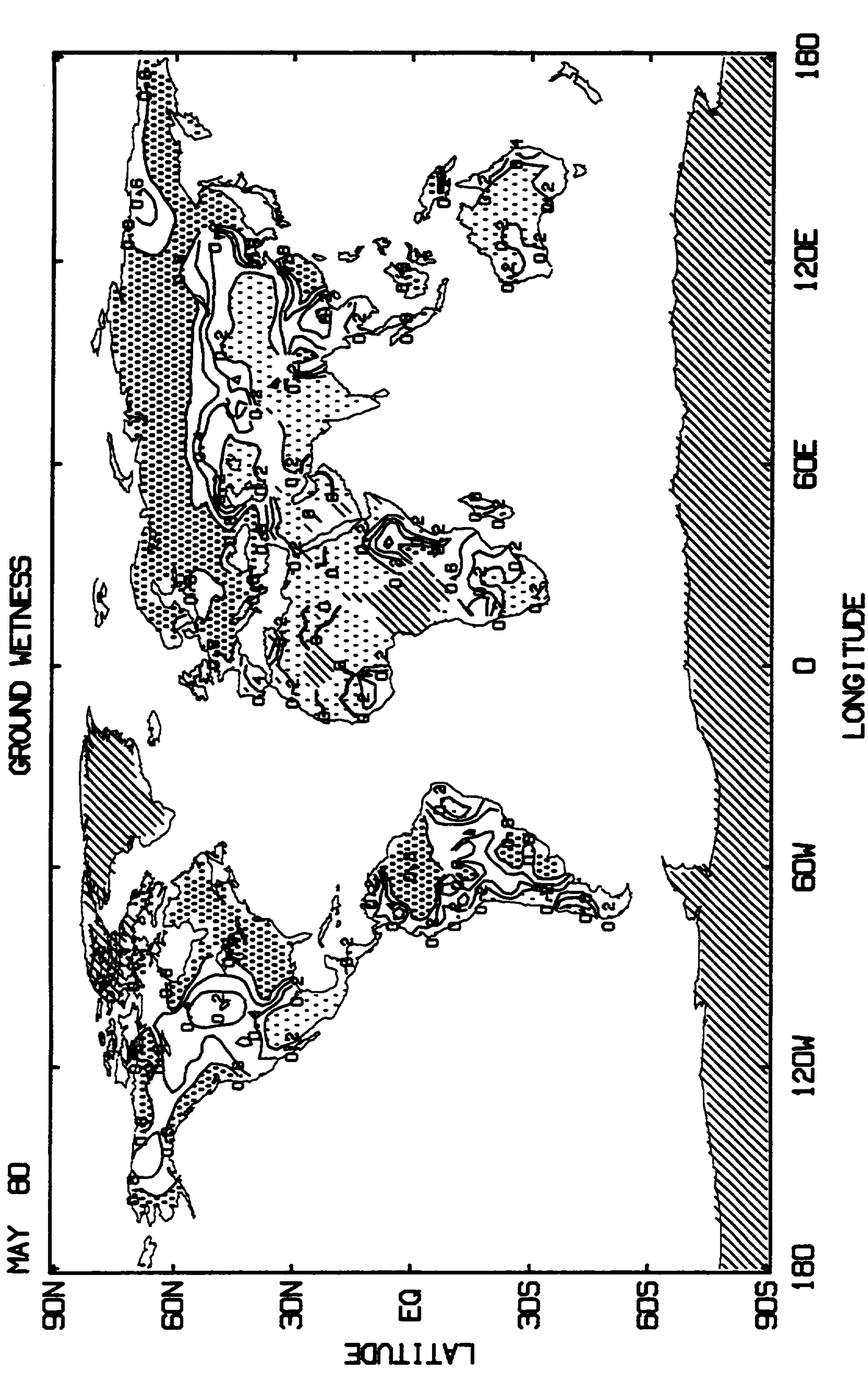
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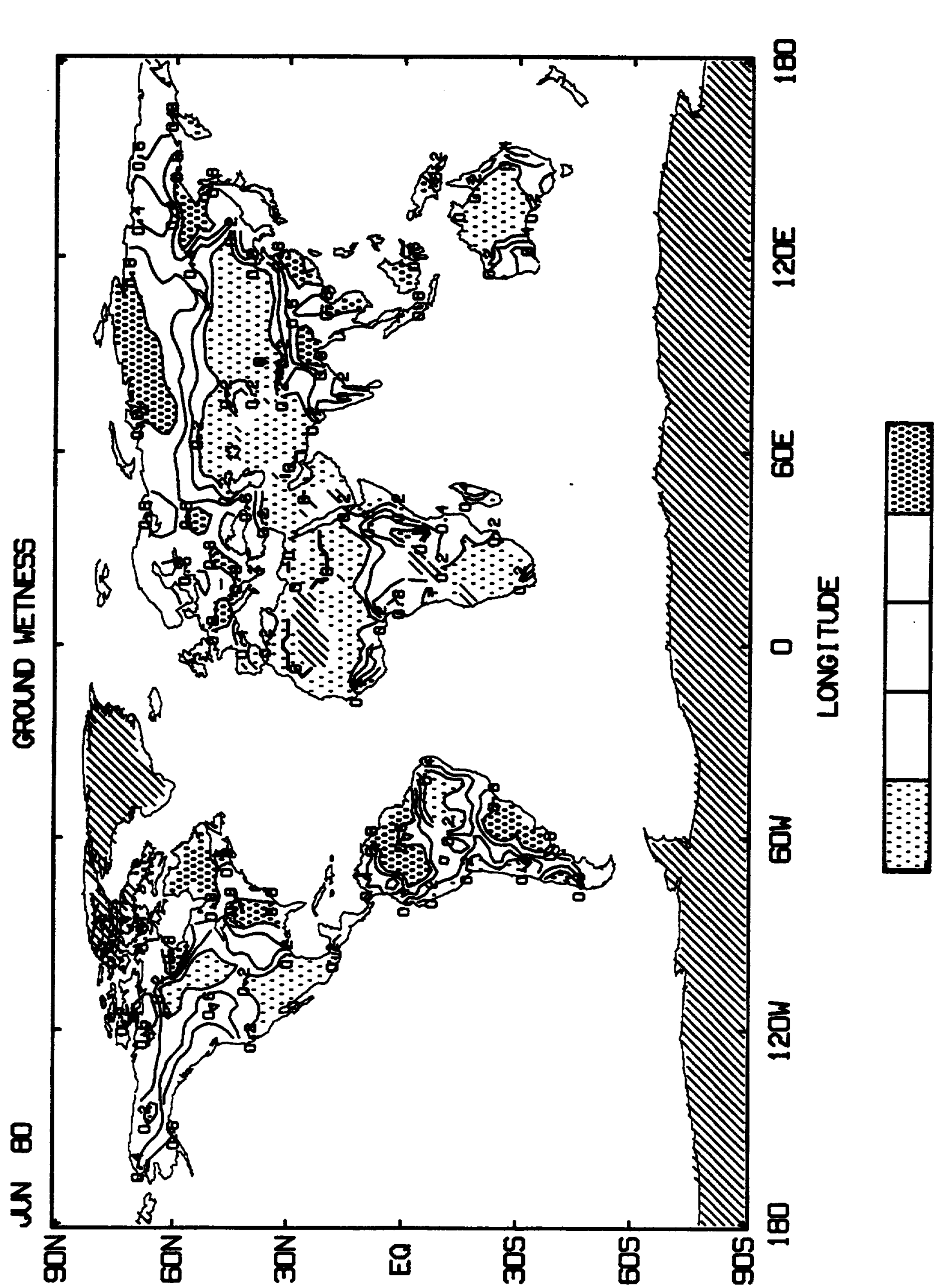

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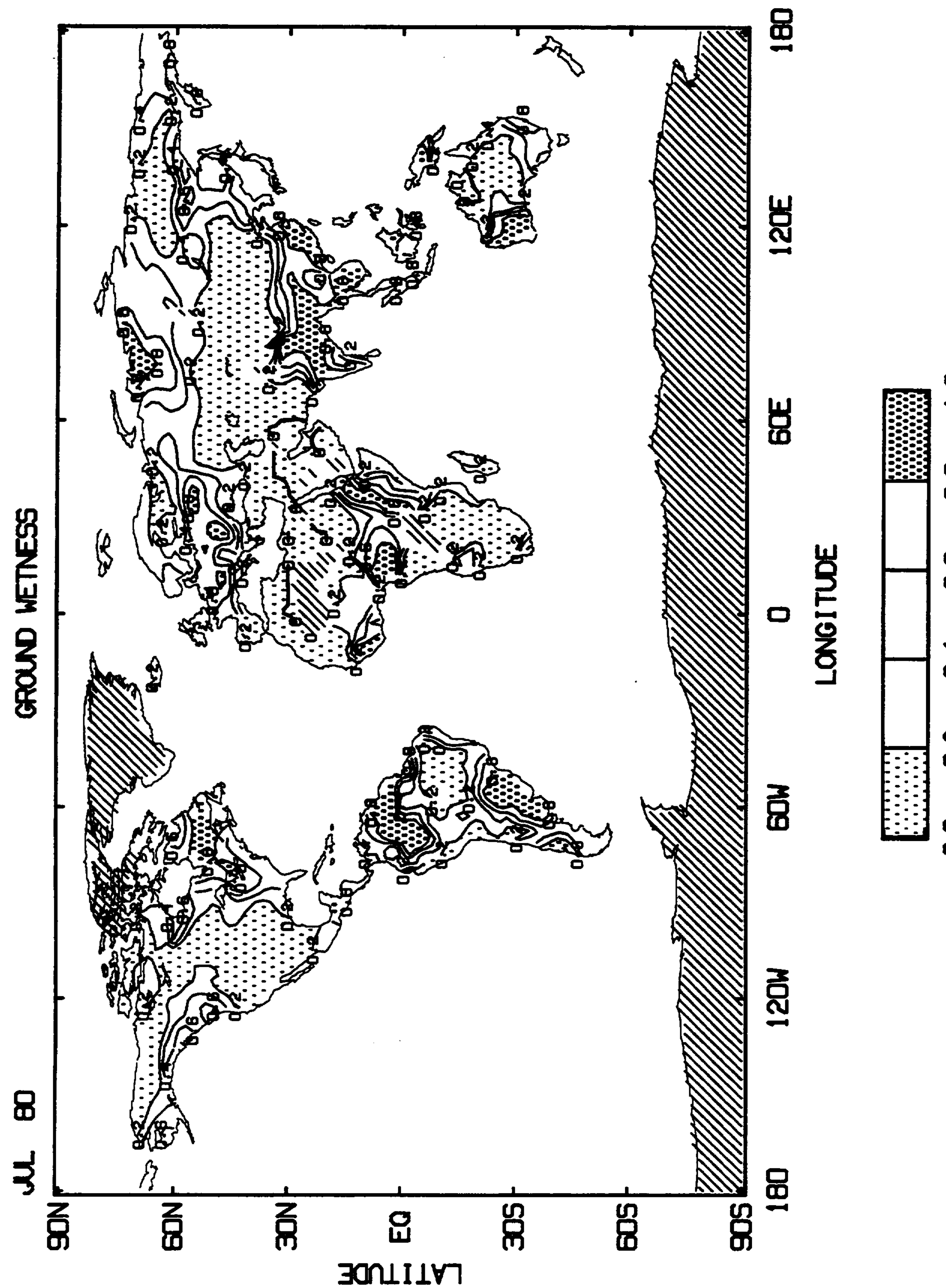
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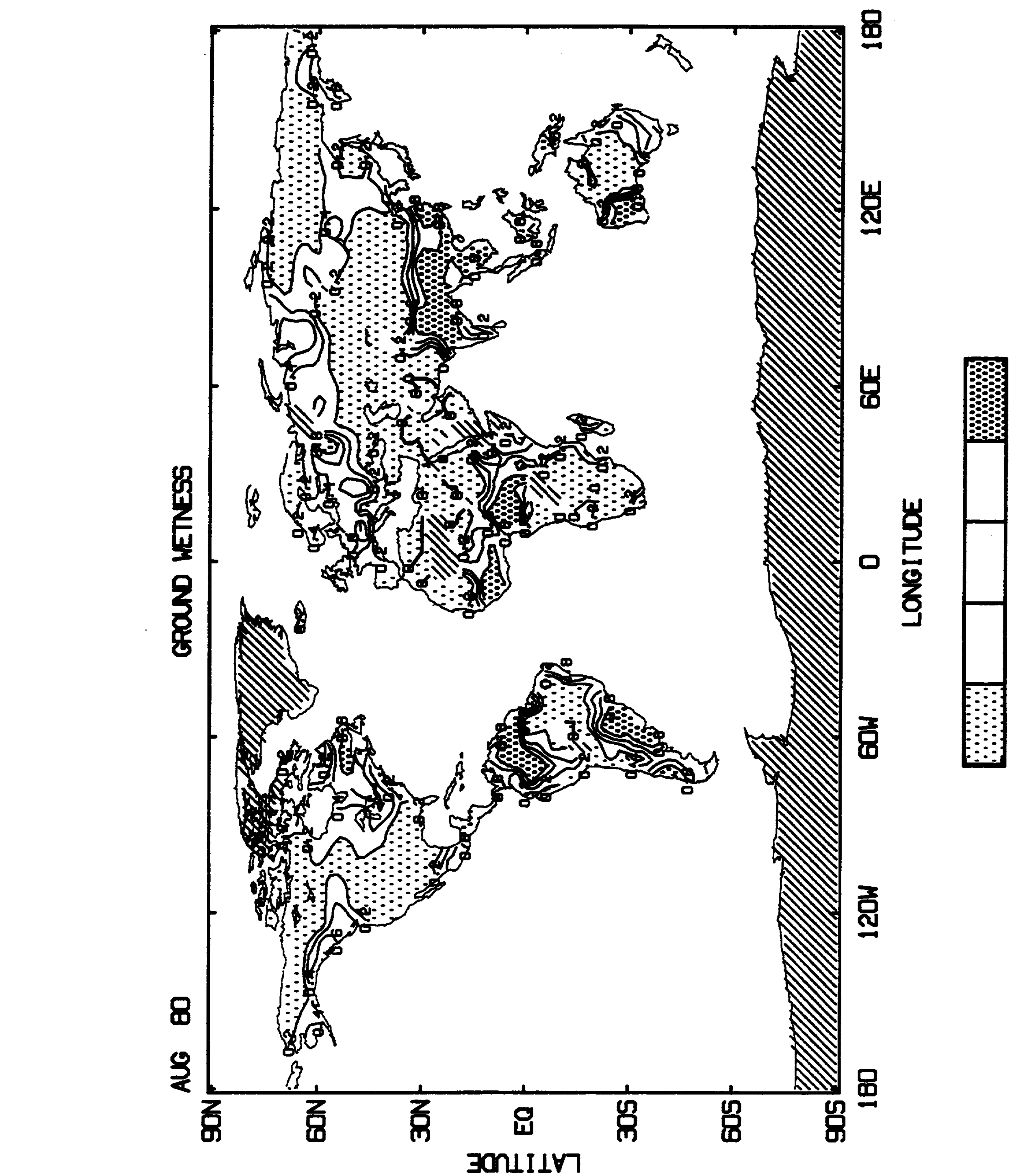

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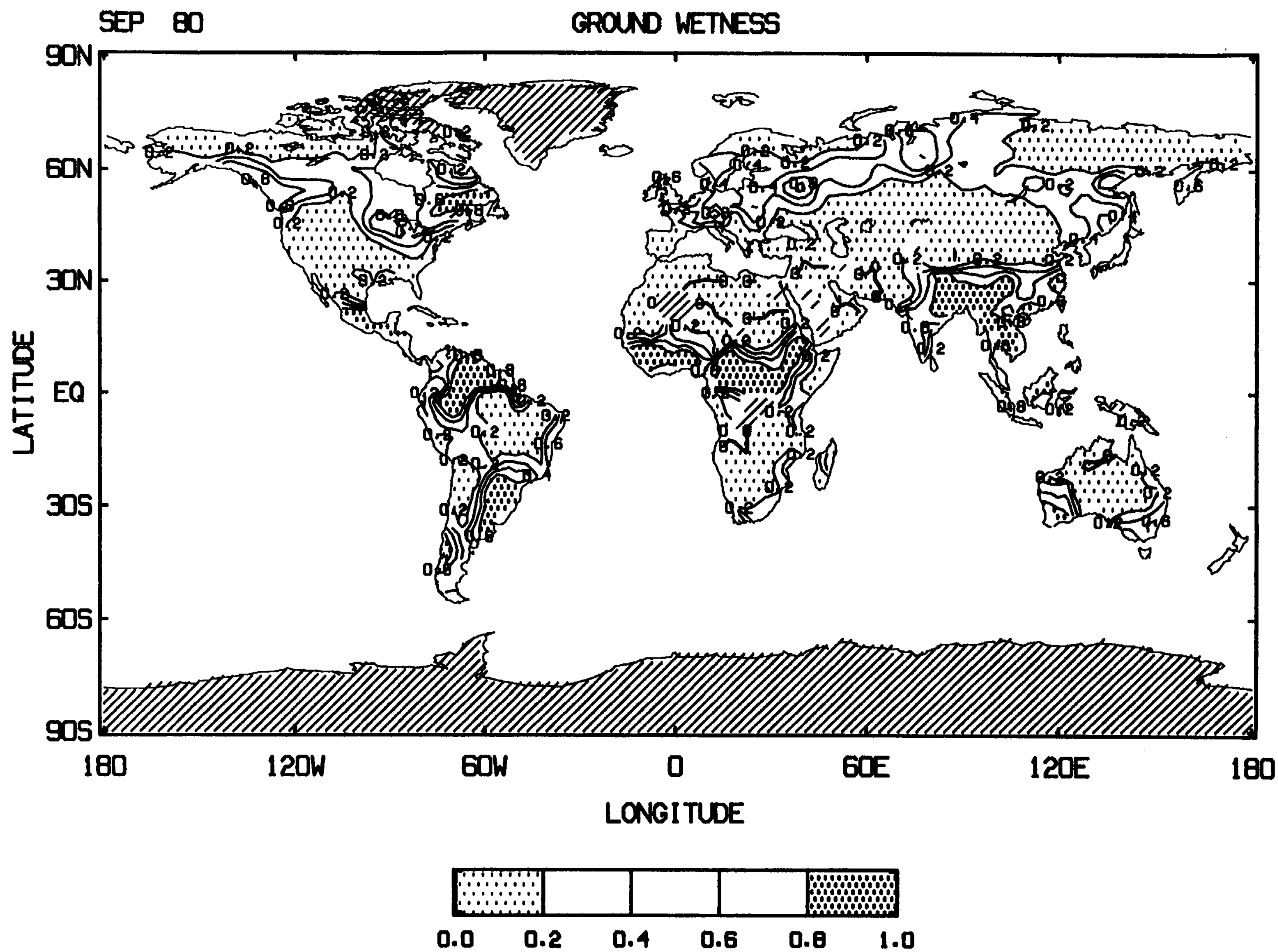

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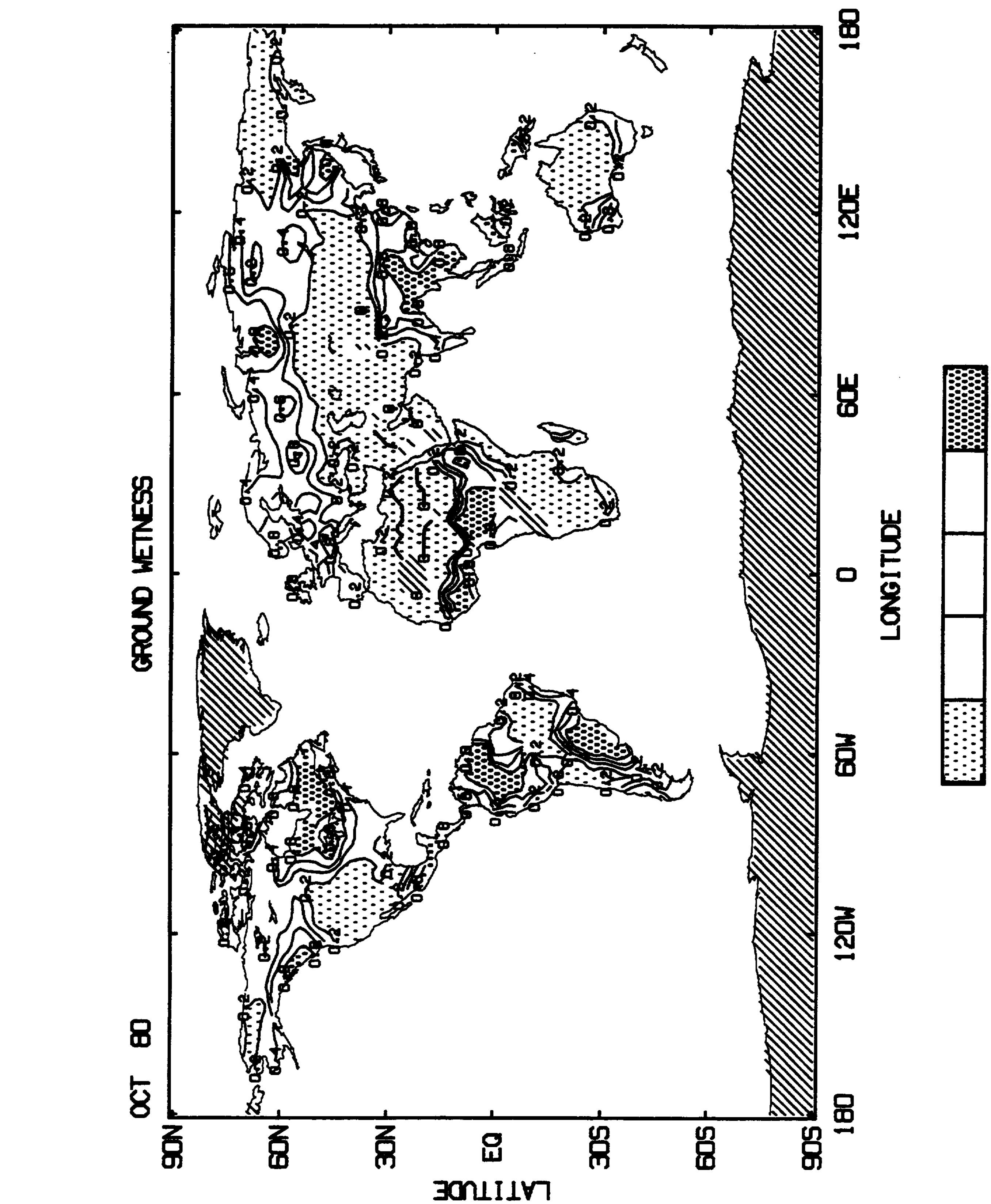
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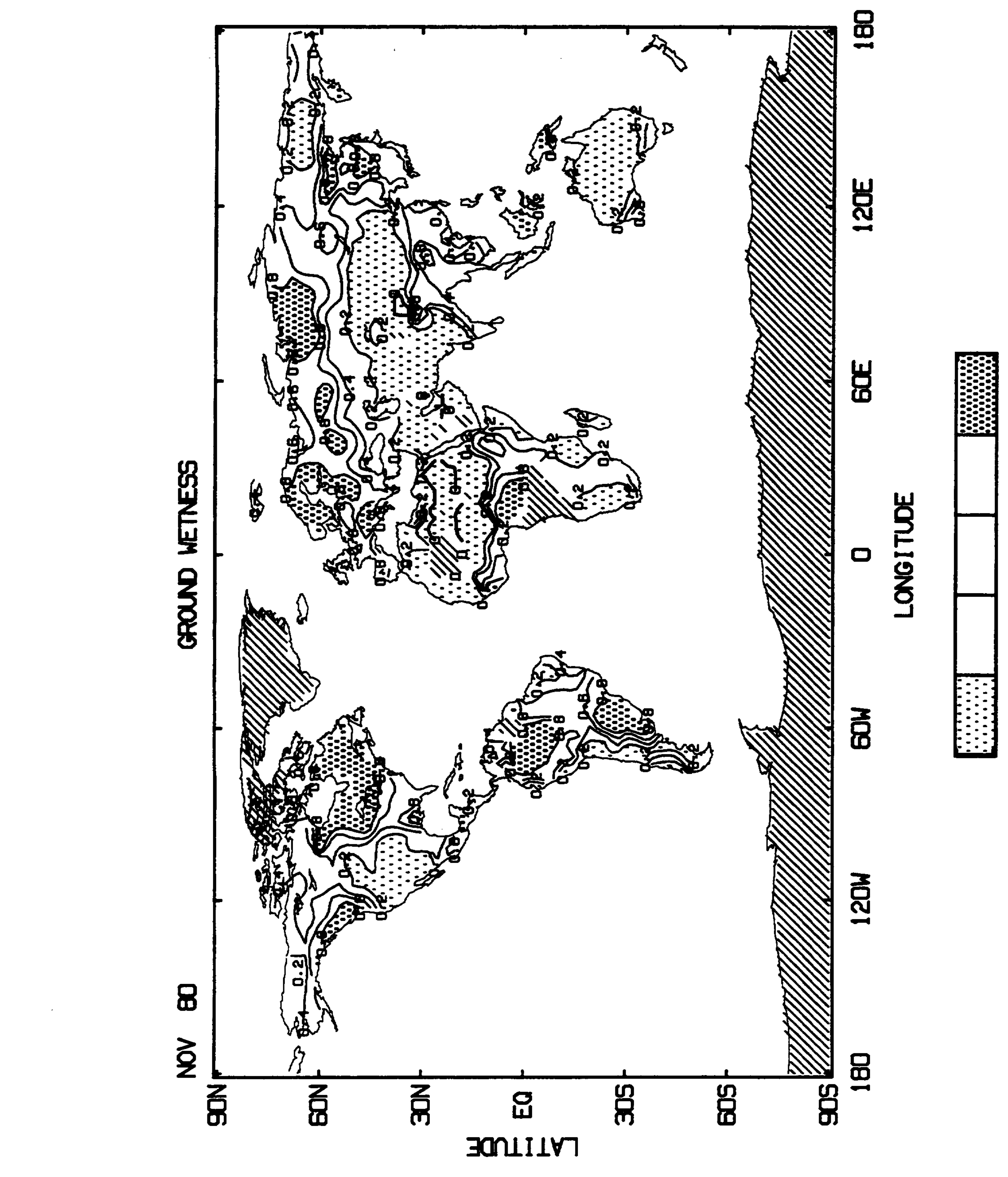
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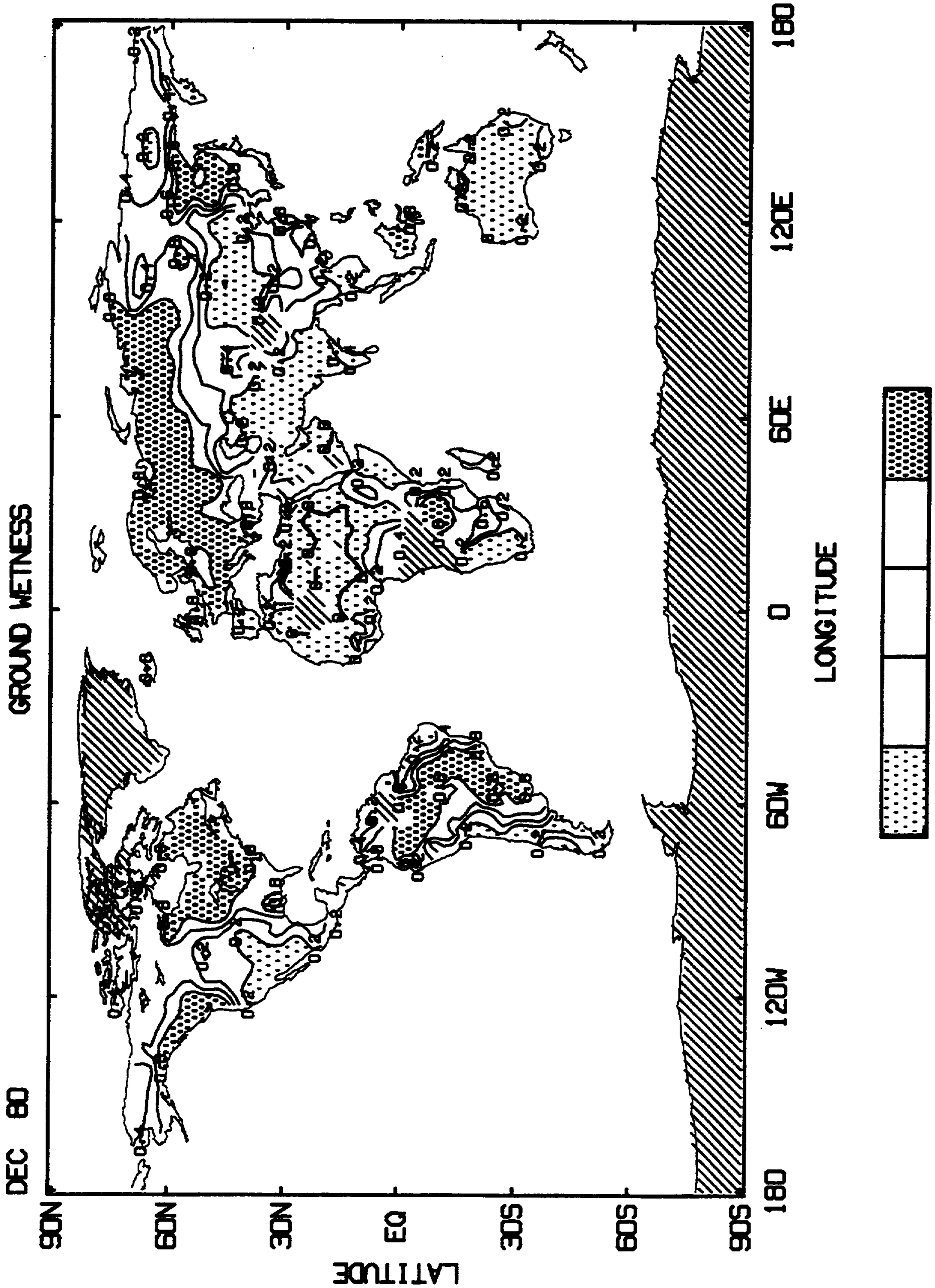

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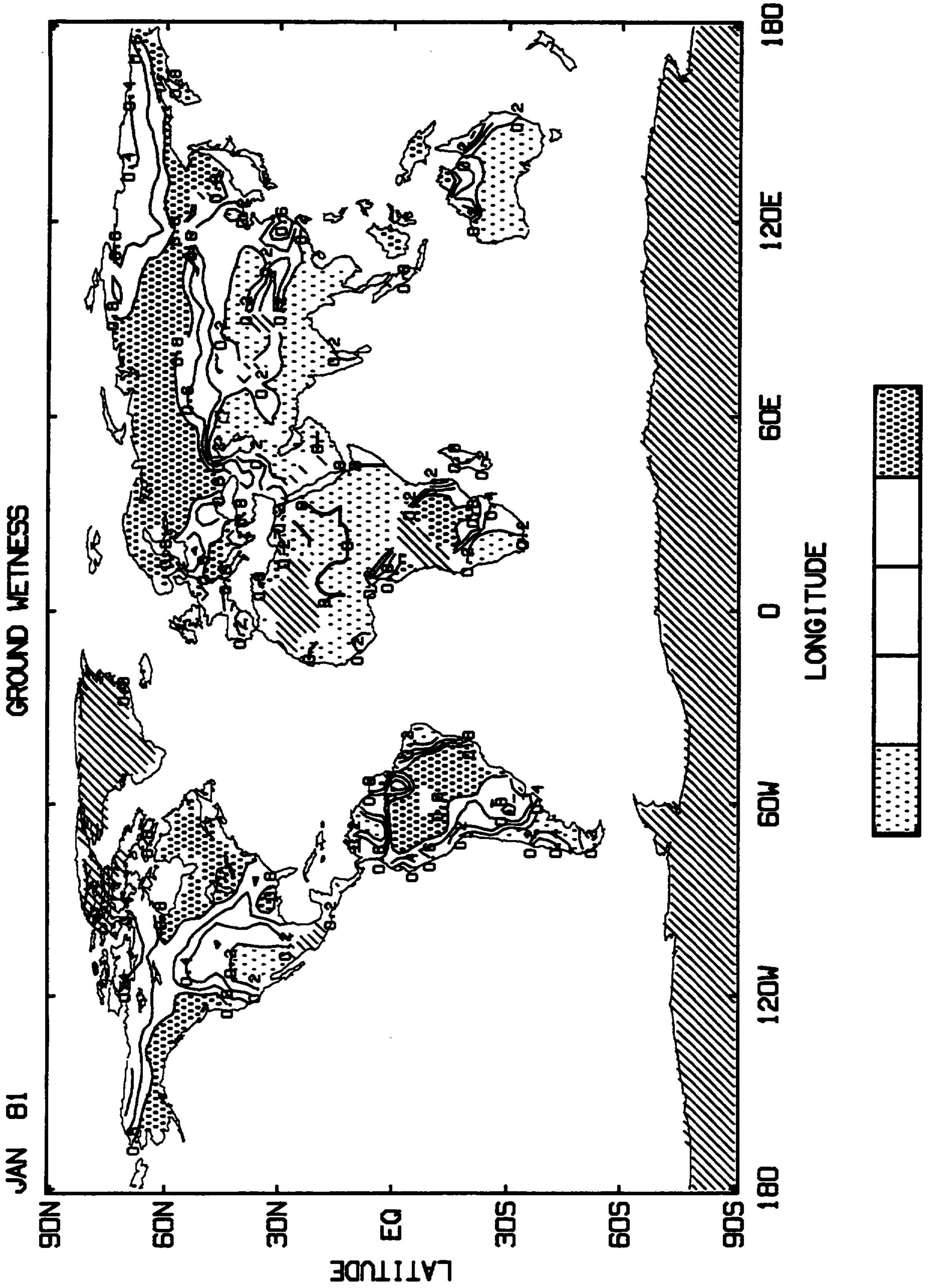
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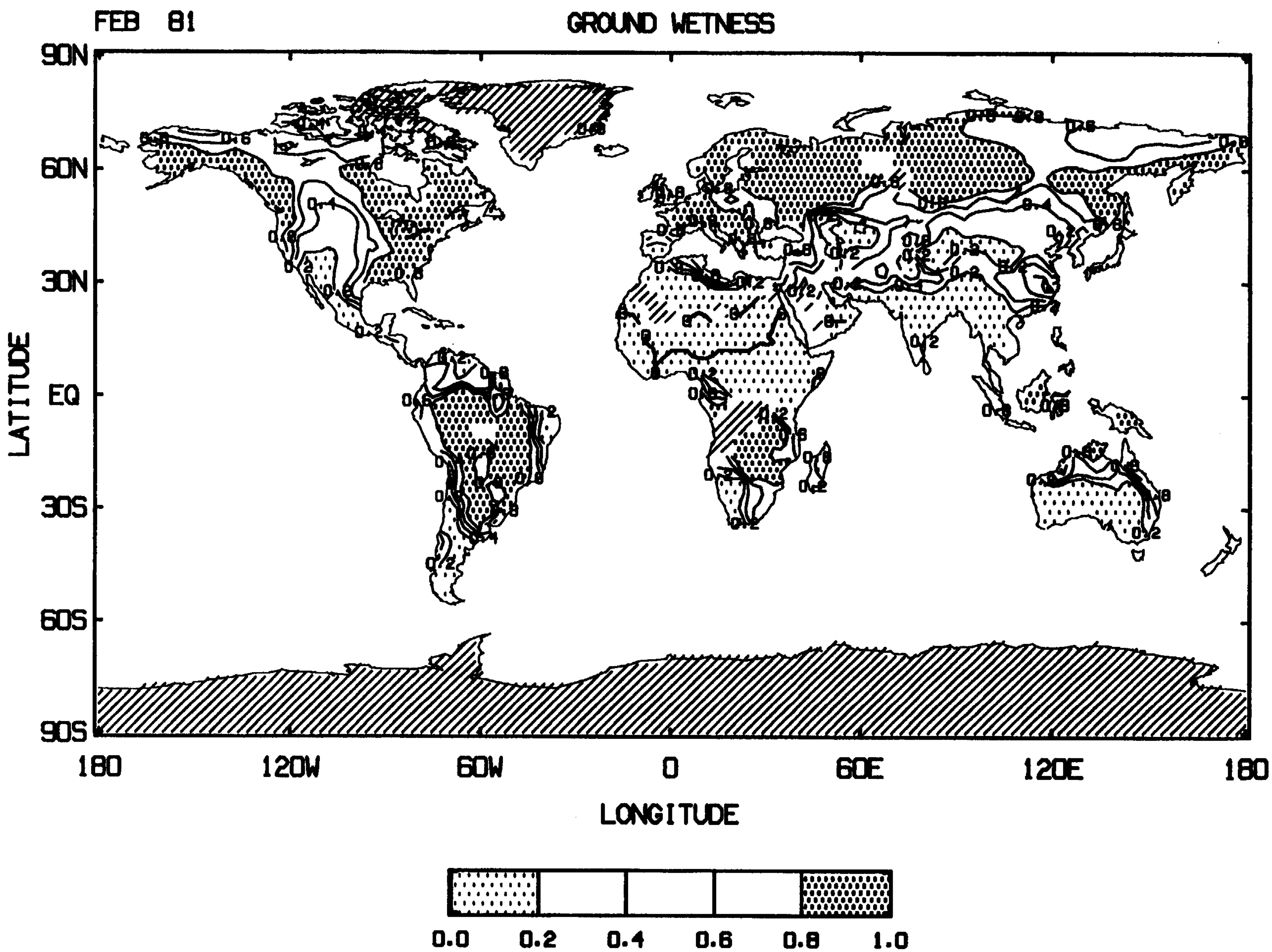
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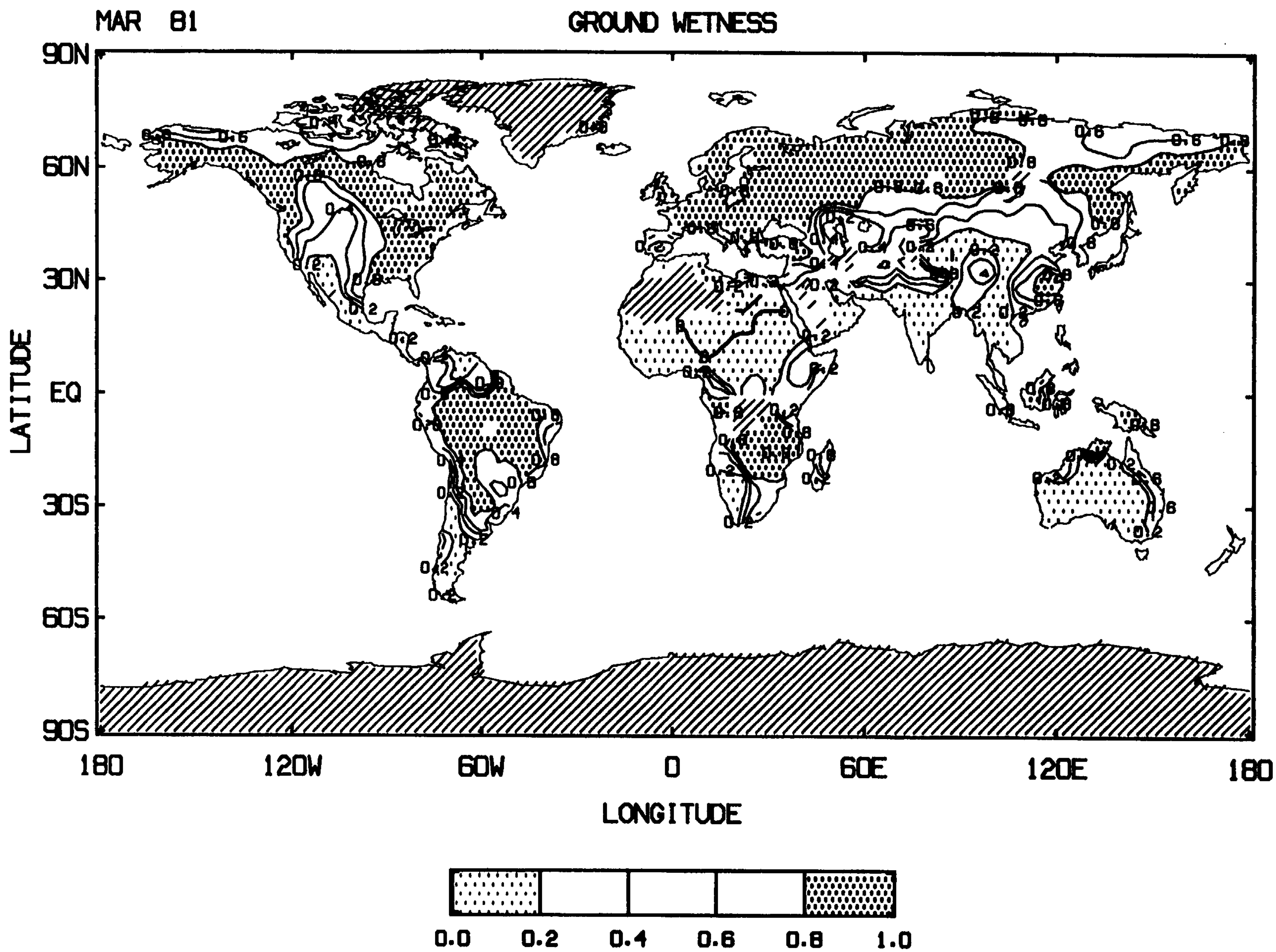
MAR 81
GROUND WETNESS
90N
60N
30N
EQ
30S
60S
90S
LATITUDE
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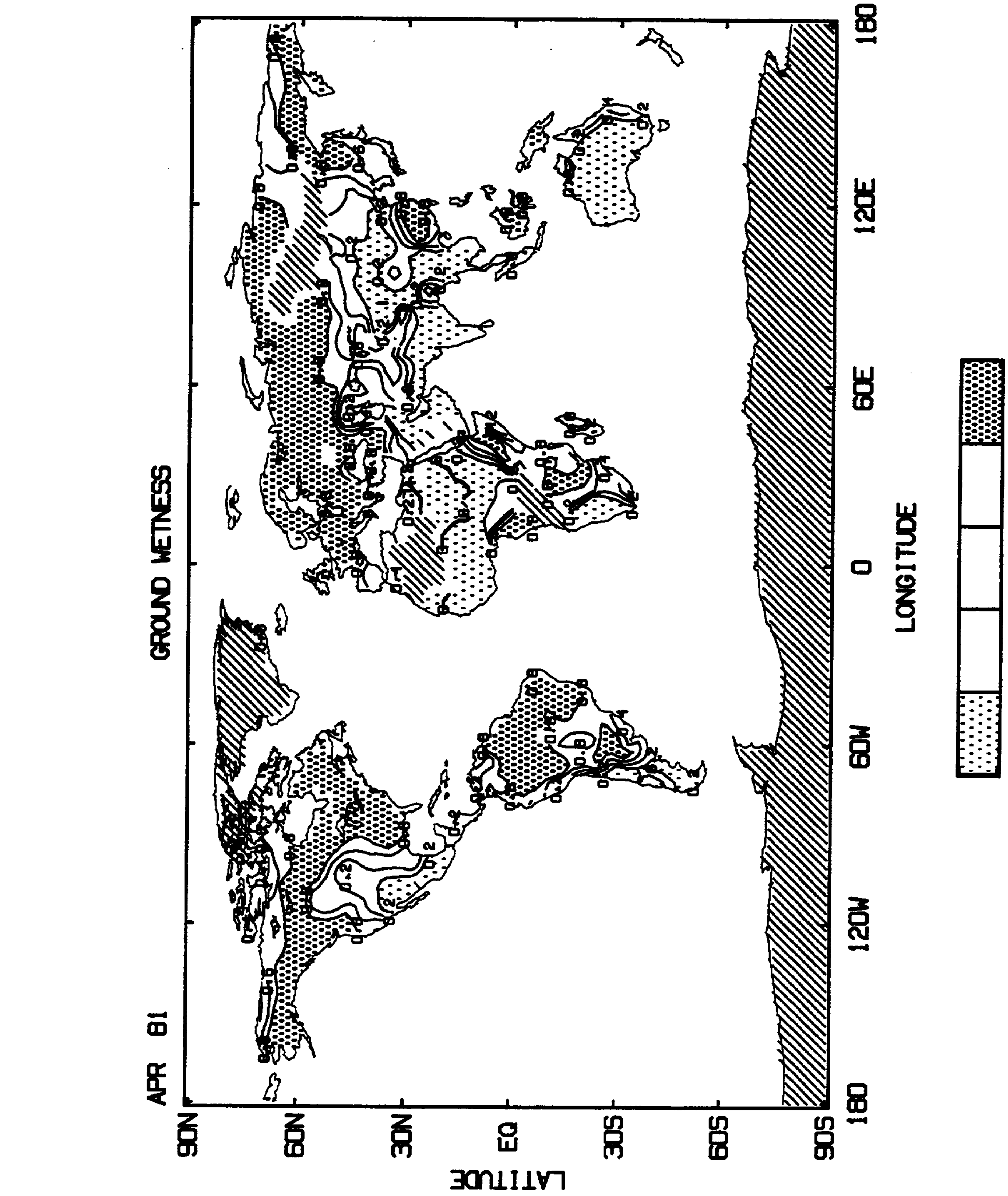
GROUND WETNESS
APR 81
LATITUDE
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EQ
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60S
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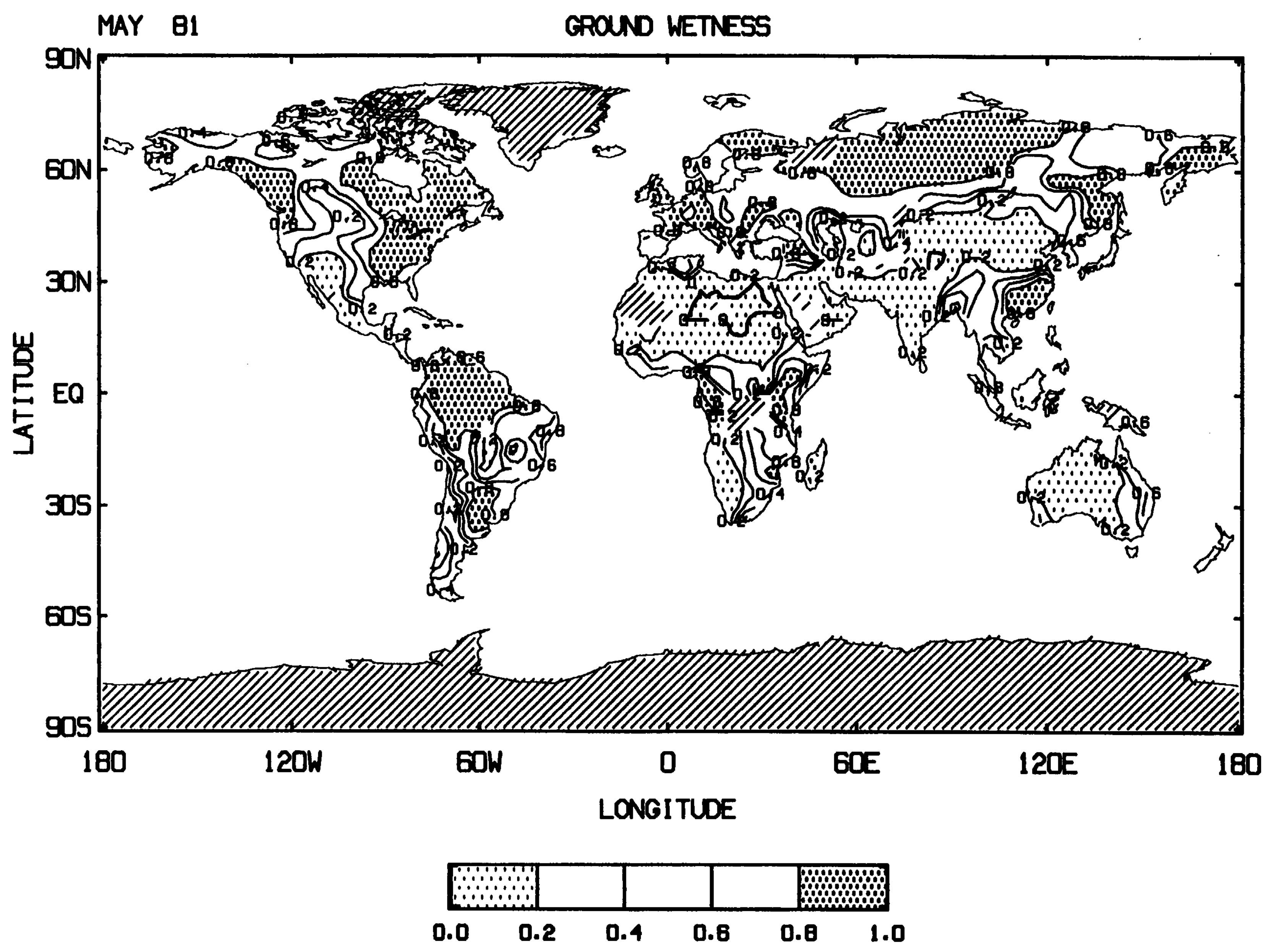
MAY 81
GROUND WETNESS
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60N
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EQ
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60S
90S
LATITUDE
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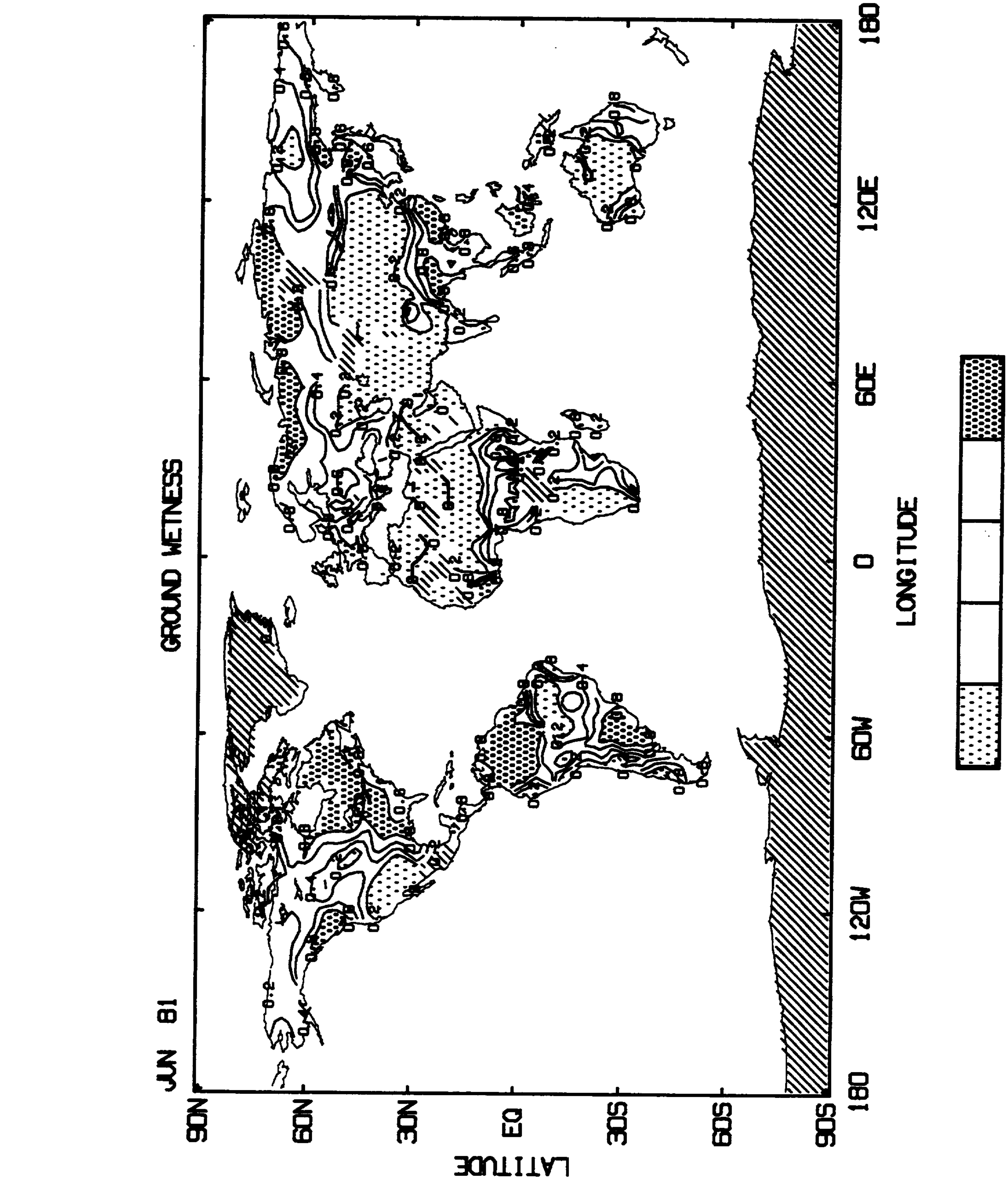

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GROUND WETNESS
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EQ
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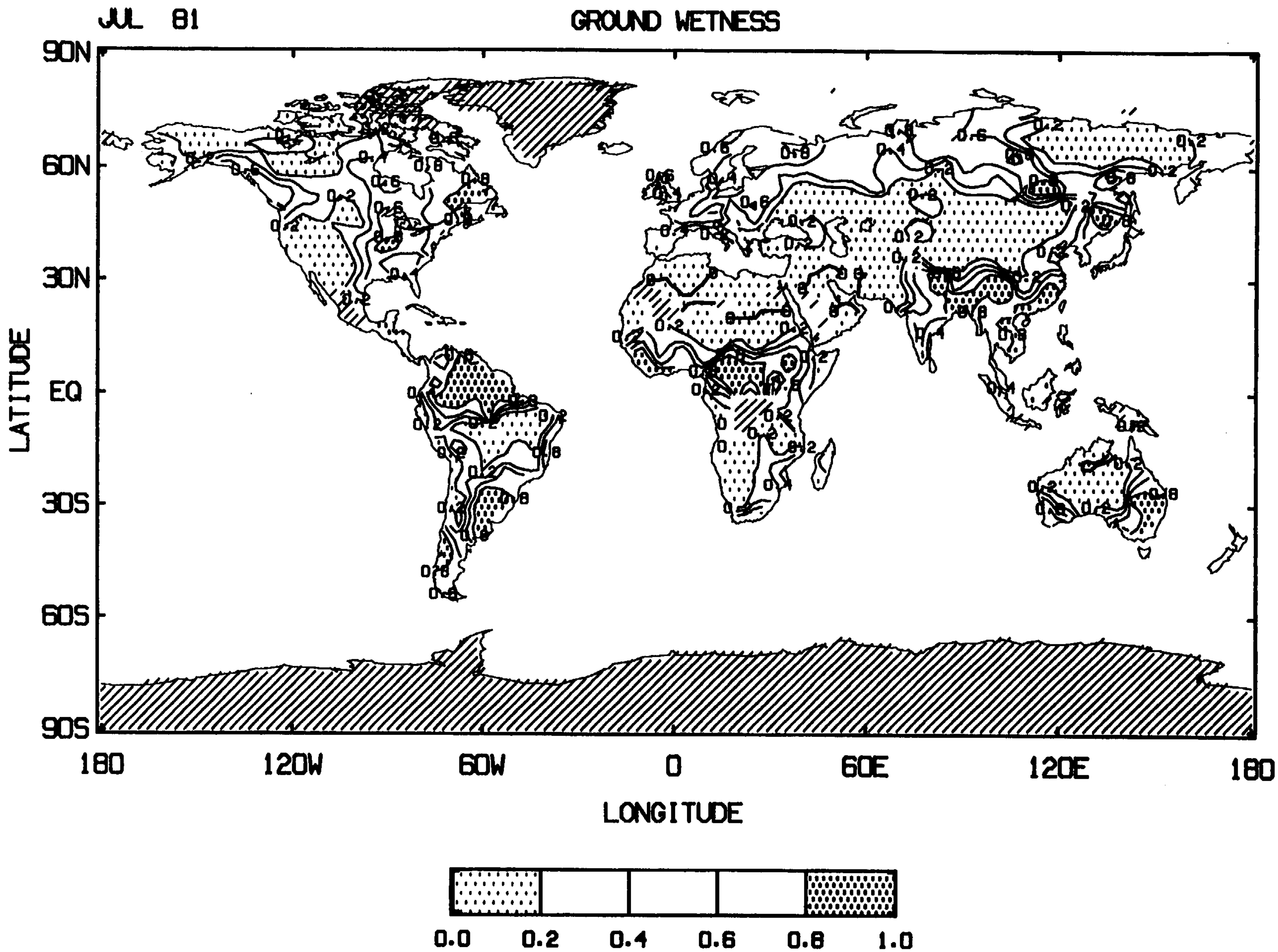
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GROUND WETNESS
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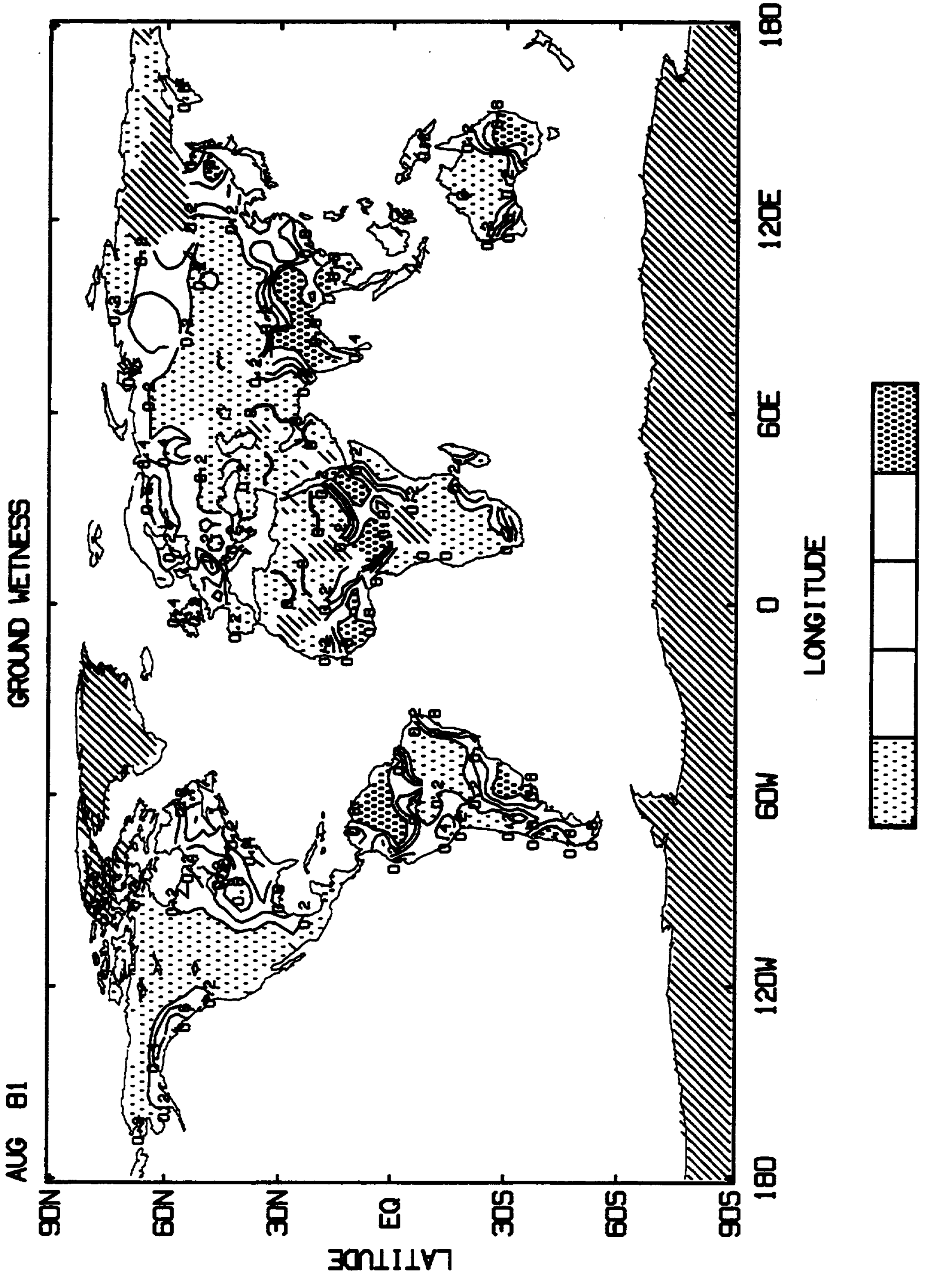

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GROUND WETNESS
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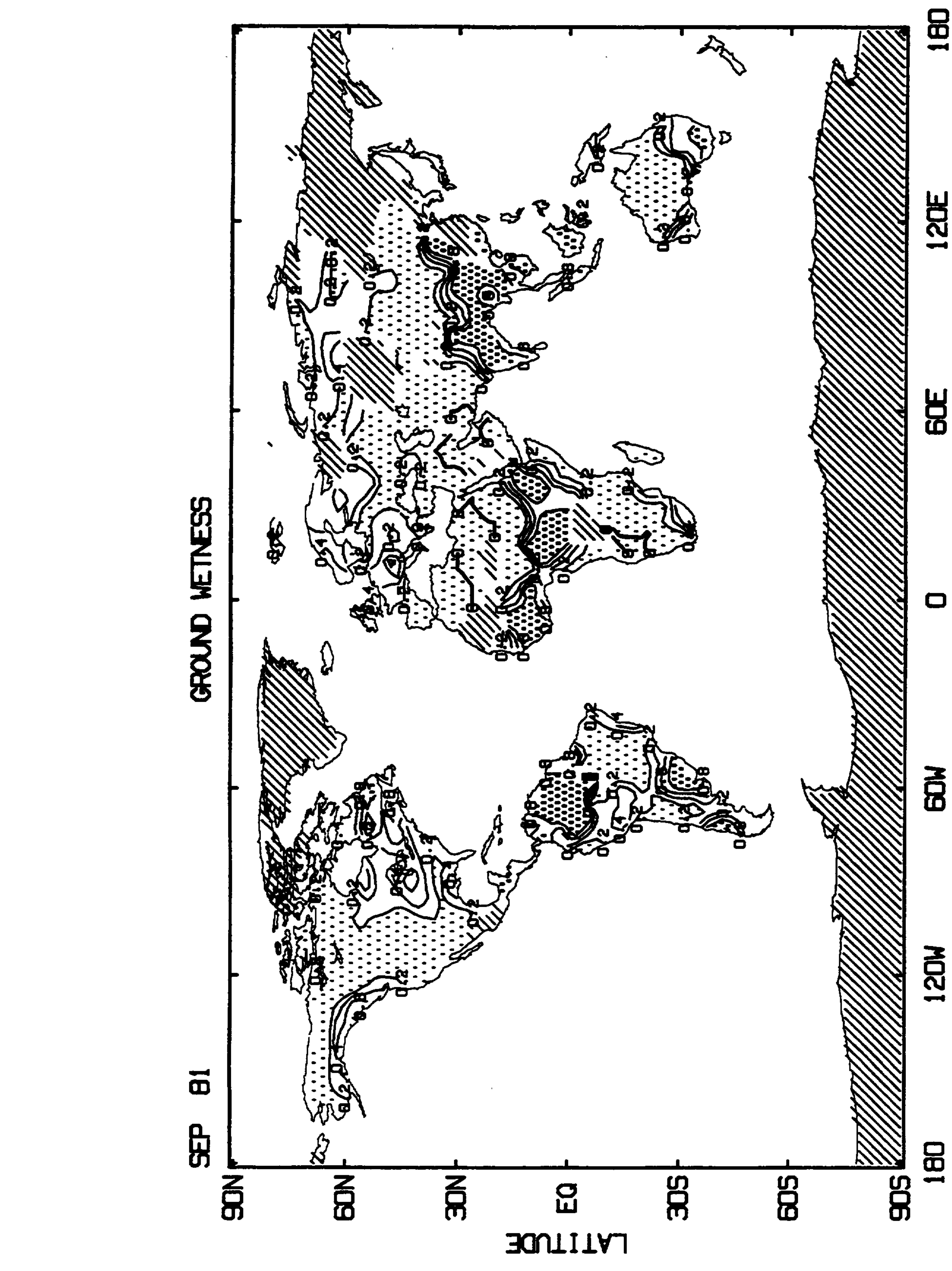
SEP 81
GROUND WETNESS
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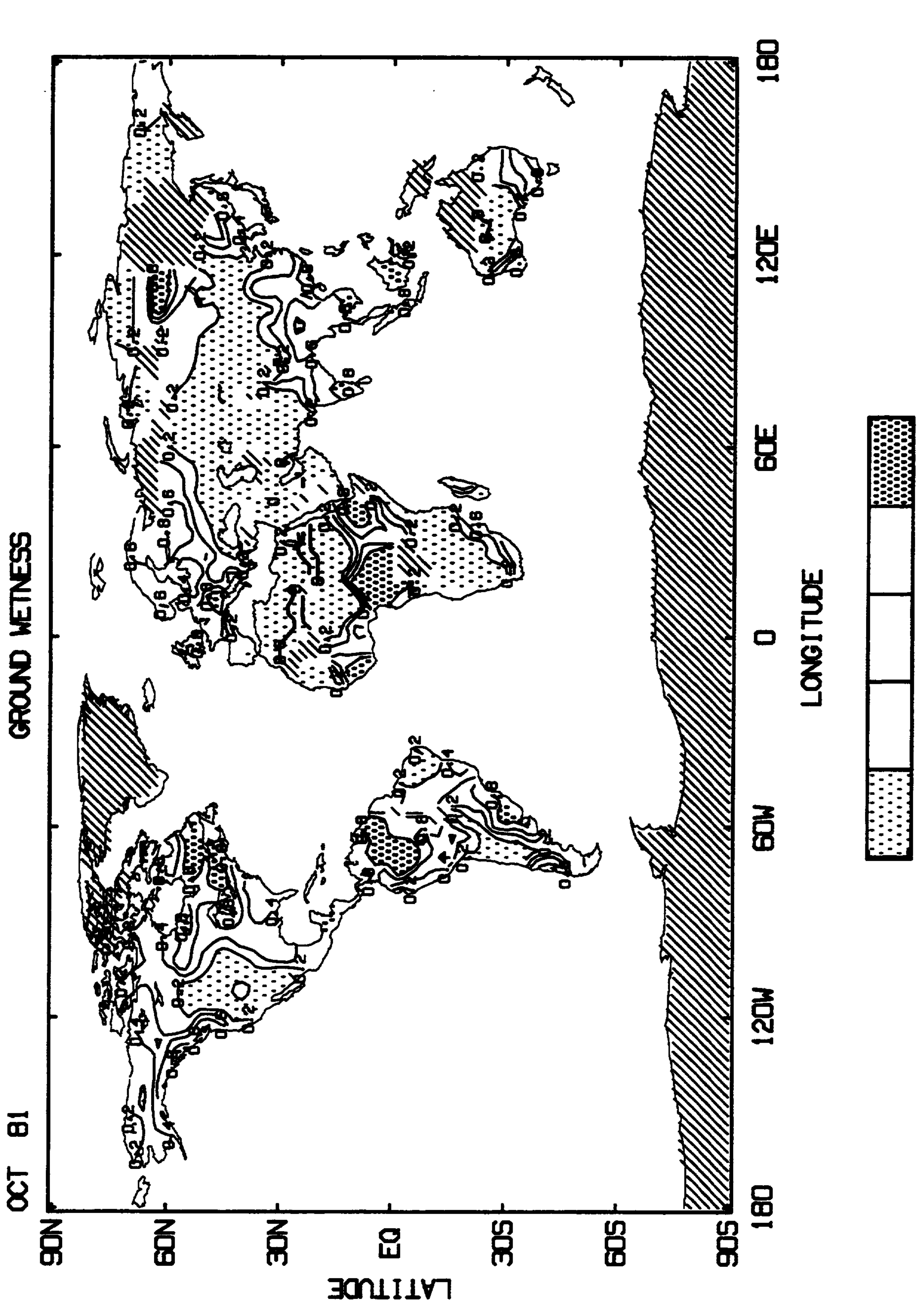
OCT 81
GROUND WETNESS
LATITUDE
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EQ
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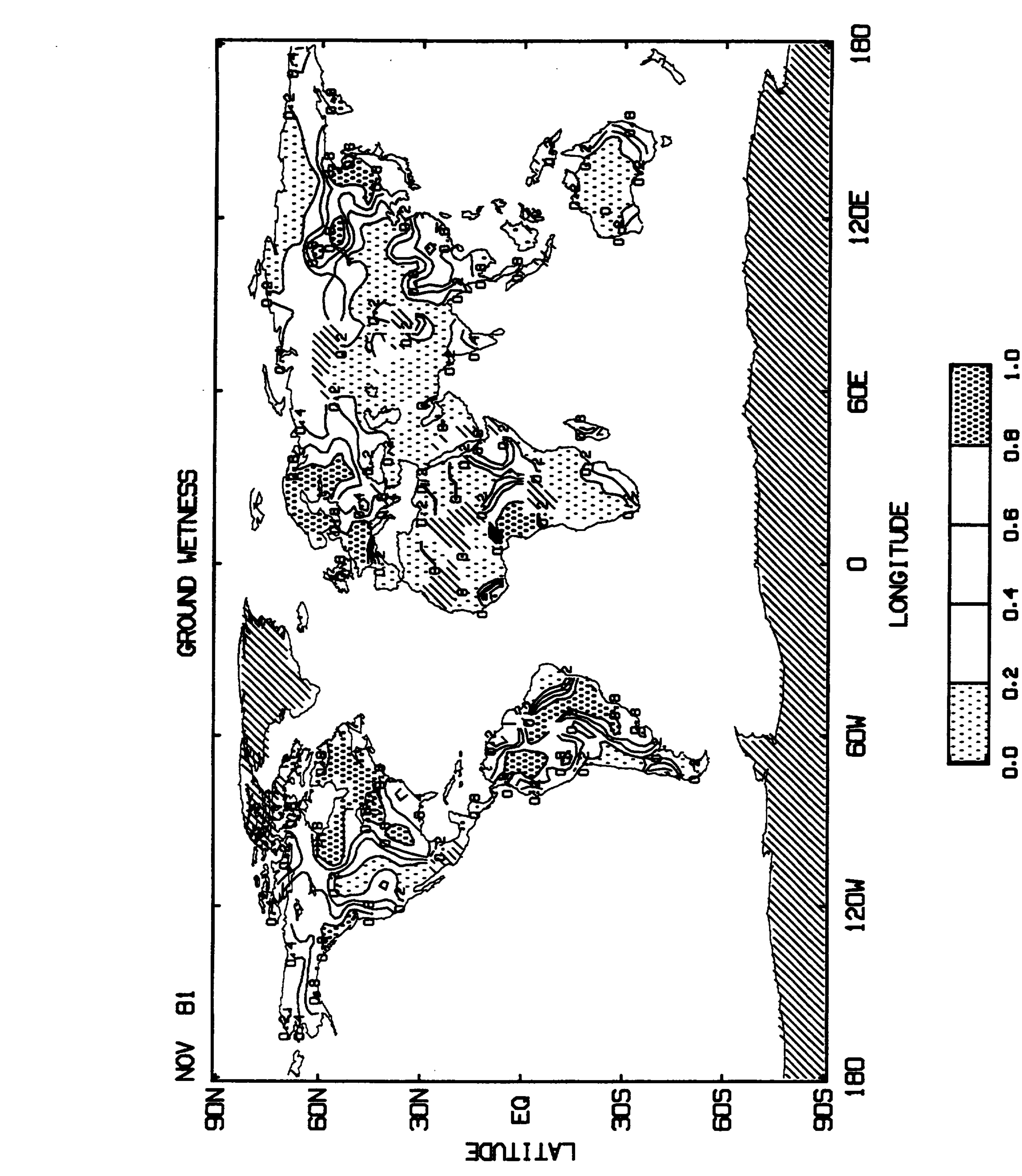
NOV 81
GROUND WETNESS
LATITUDE
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EQ
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90S
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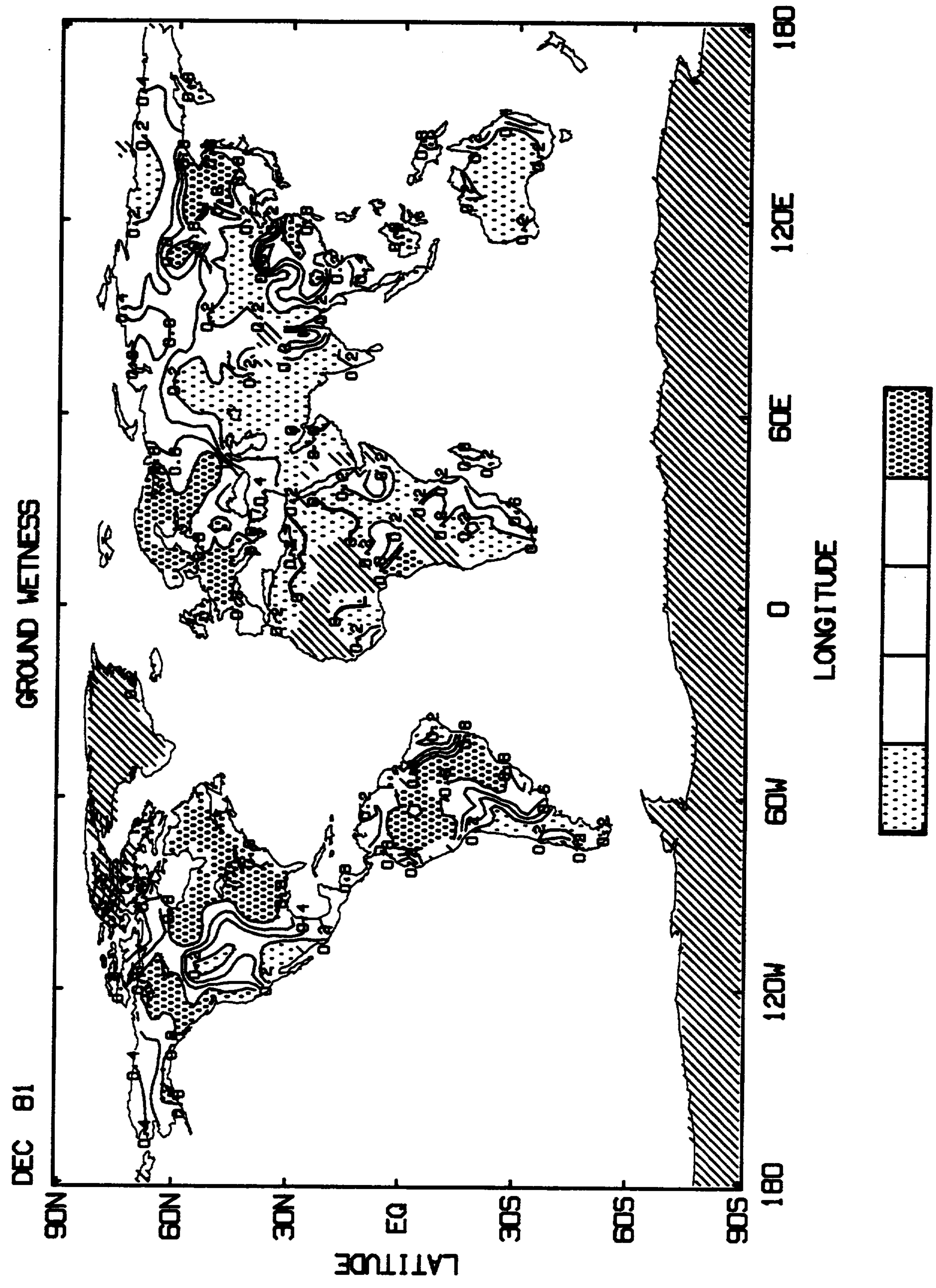
DEC 81
GROUND WETNESS
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EQ
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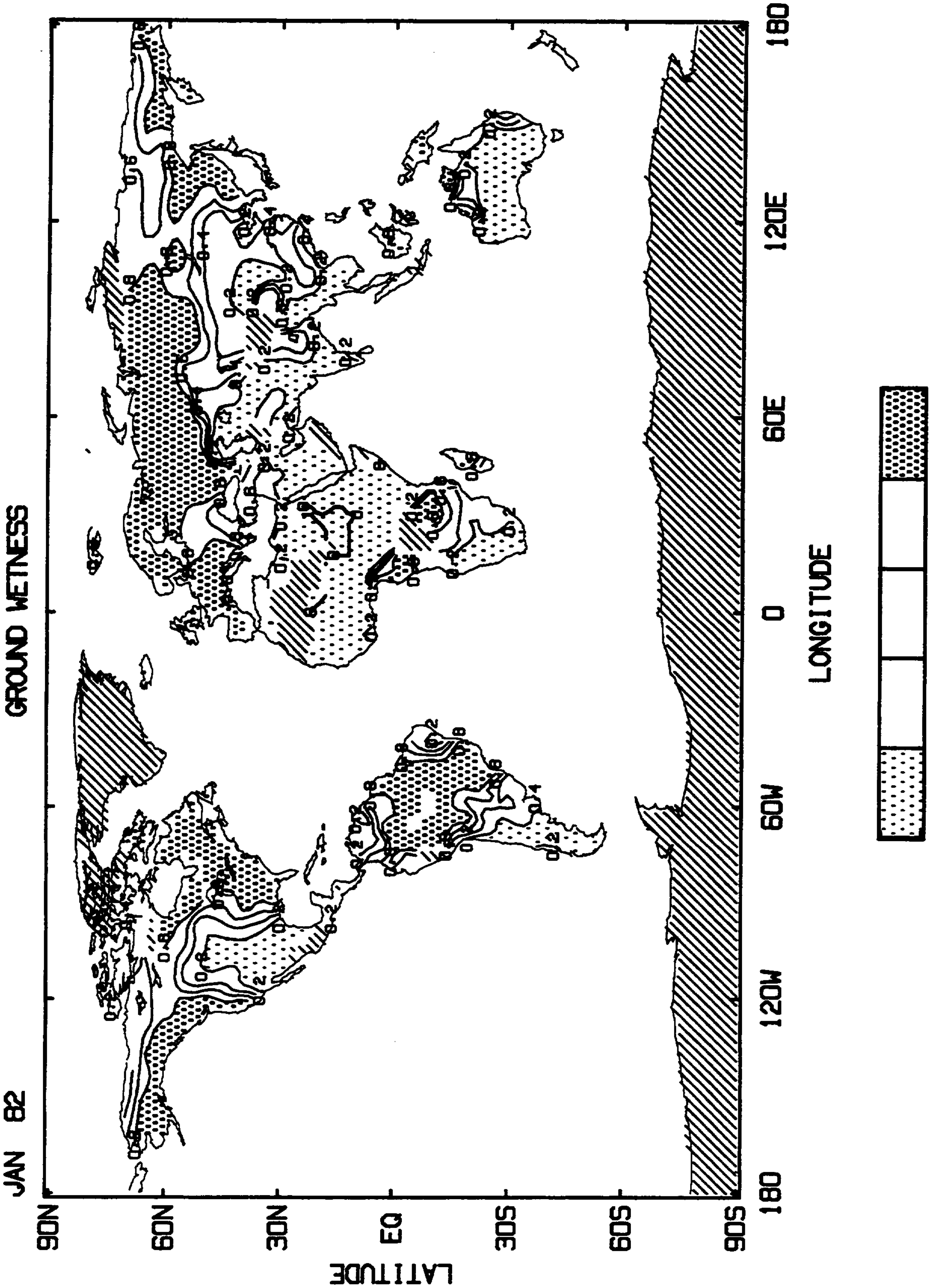
1982


JAN 82
GROUND WETNESS
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60N
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EQ
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60S
90S
LATITUDE
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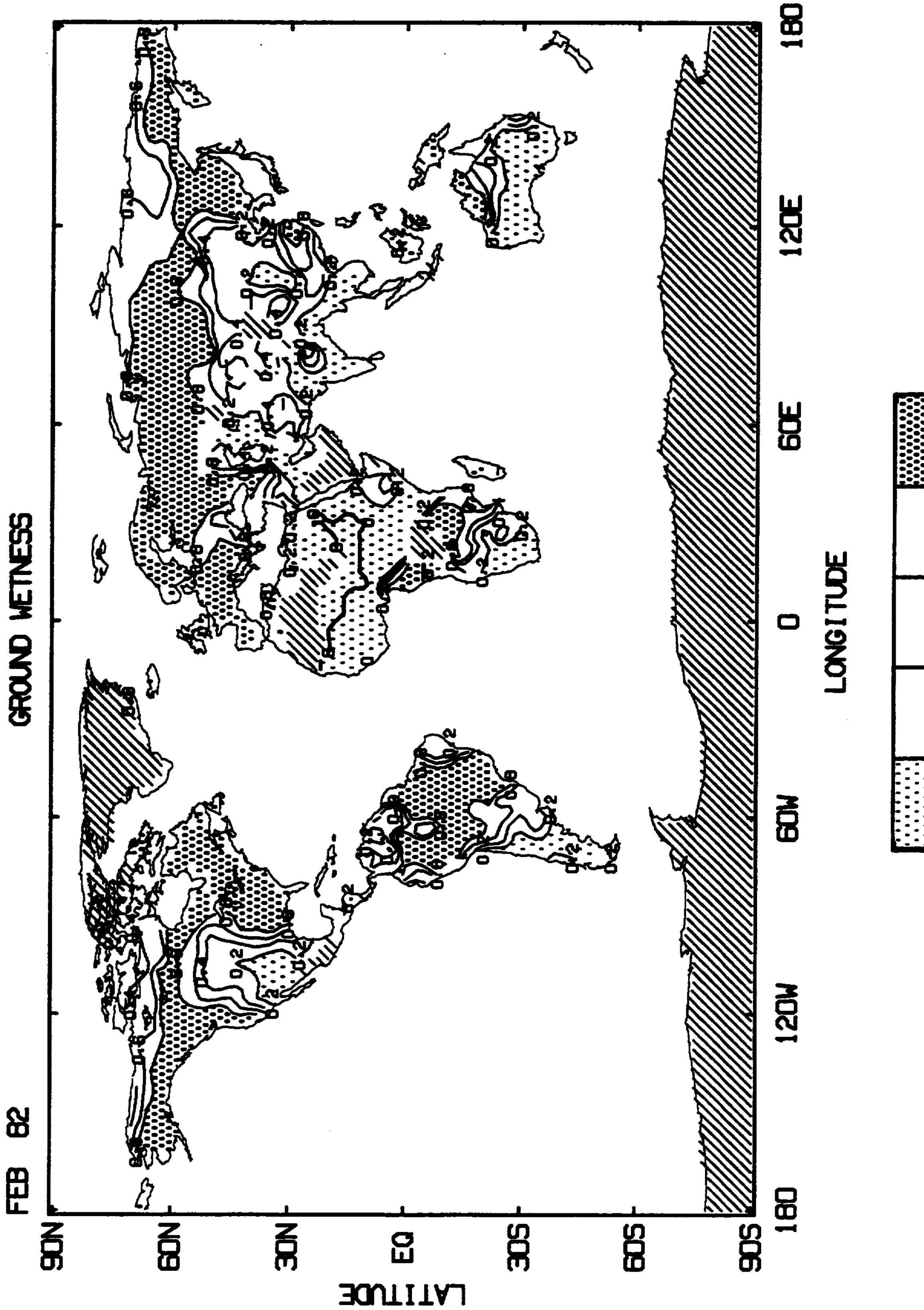
FEB 82
GROUND WETNESS
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EQ
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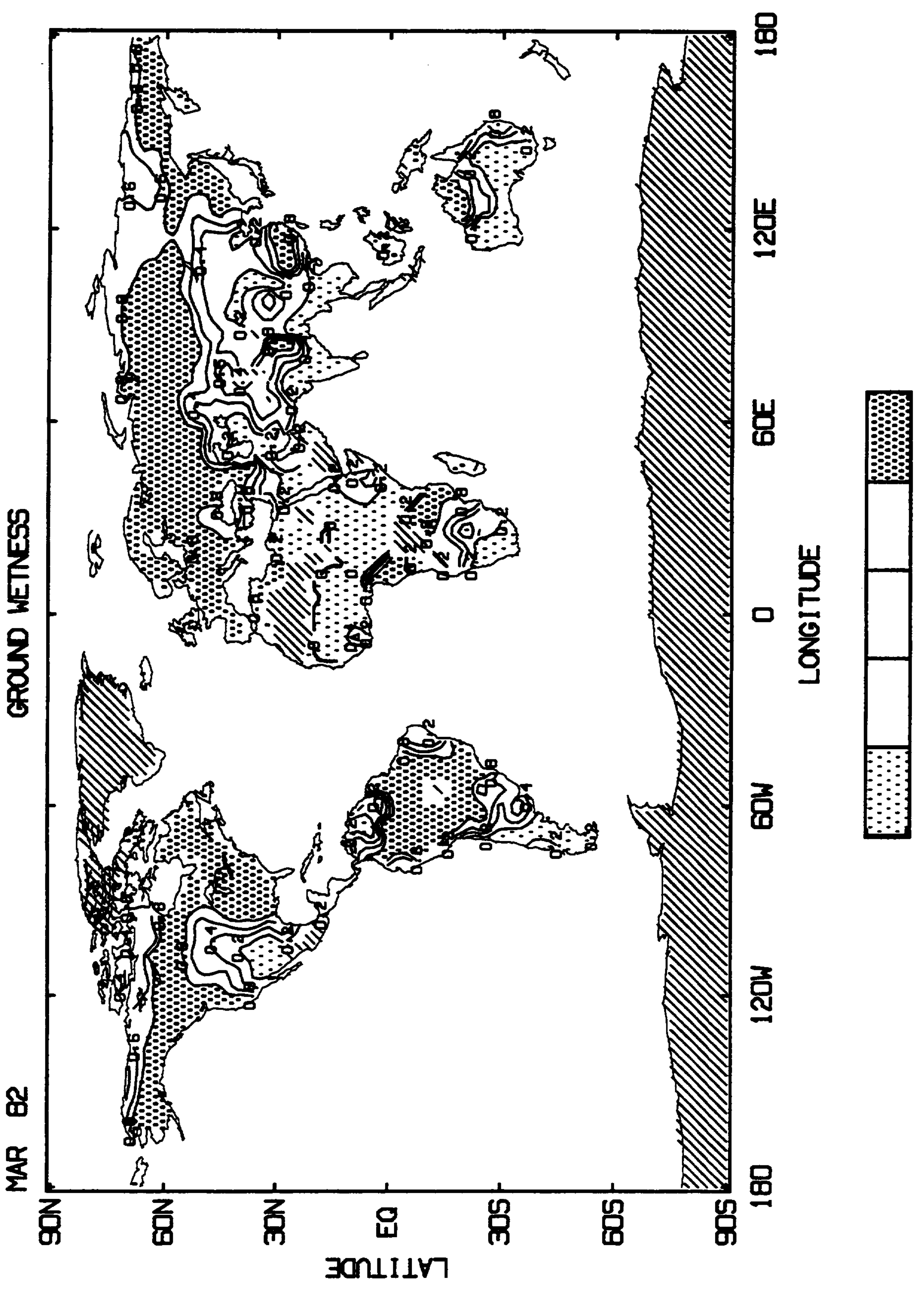

MAR 82
GROUND WETNESS
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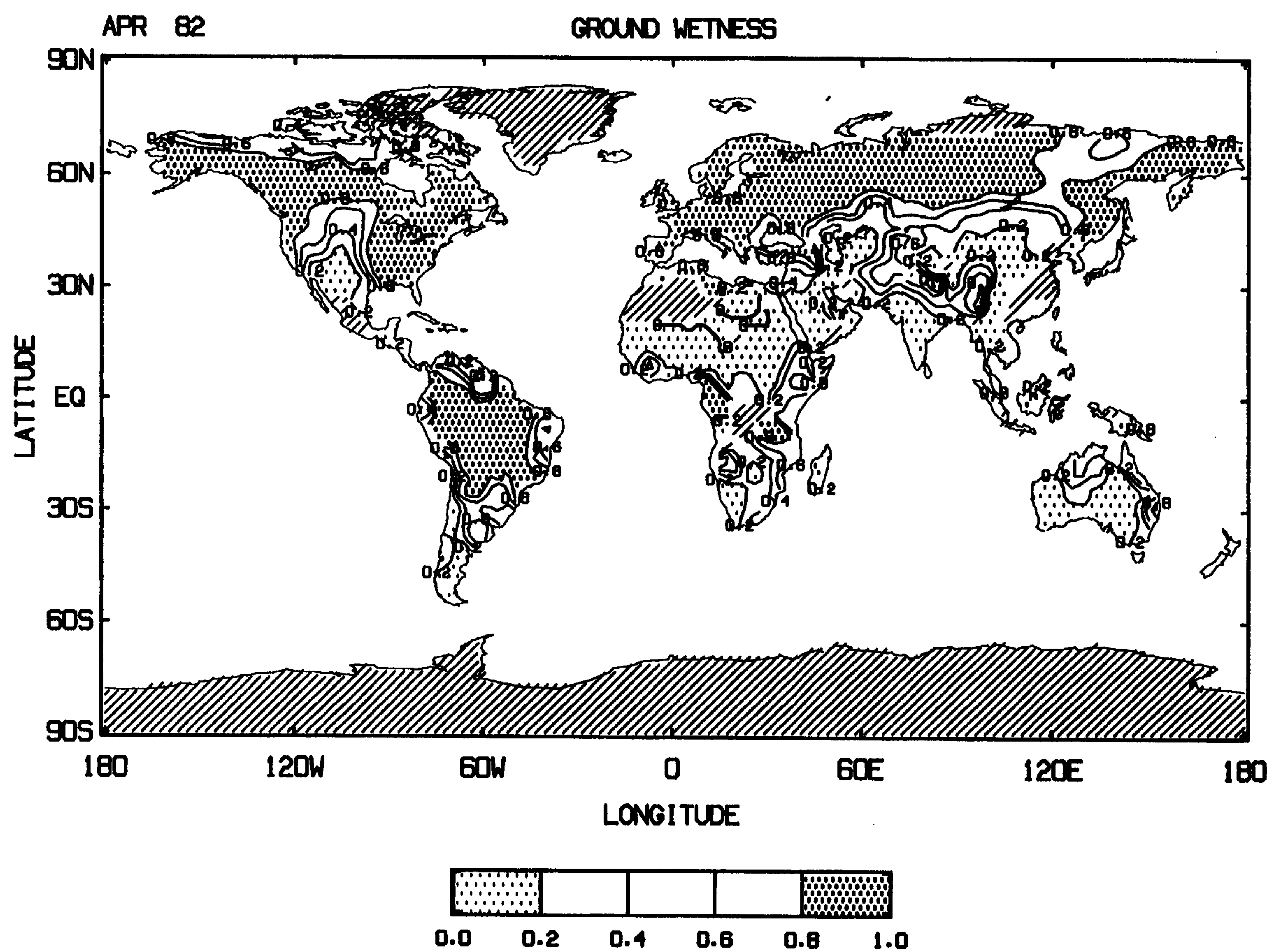

APR 82
GROUND WETNESS
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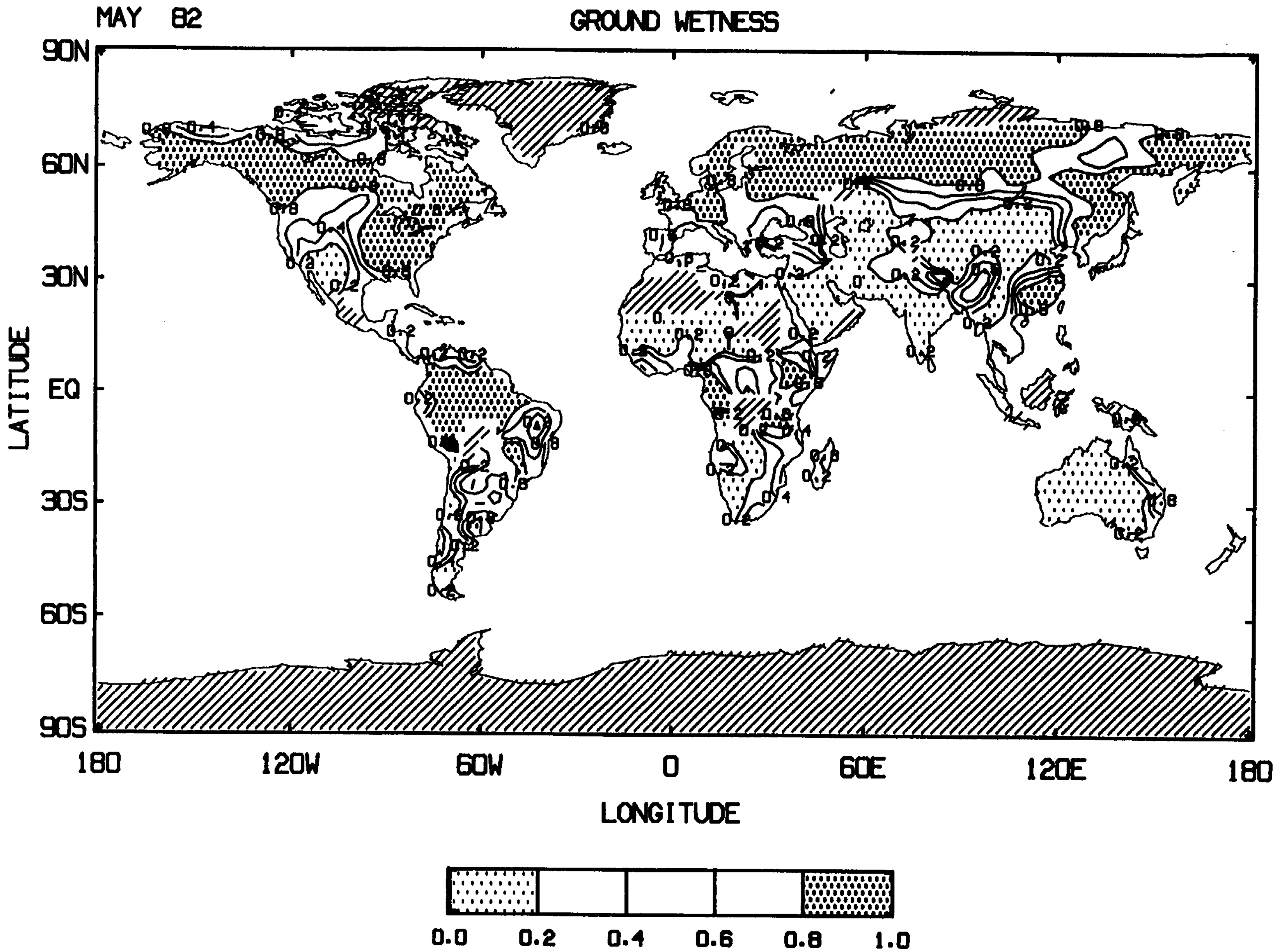
MAY 82
GROUND WETNESS
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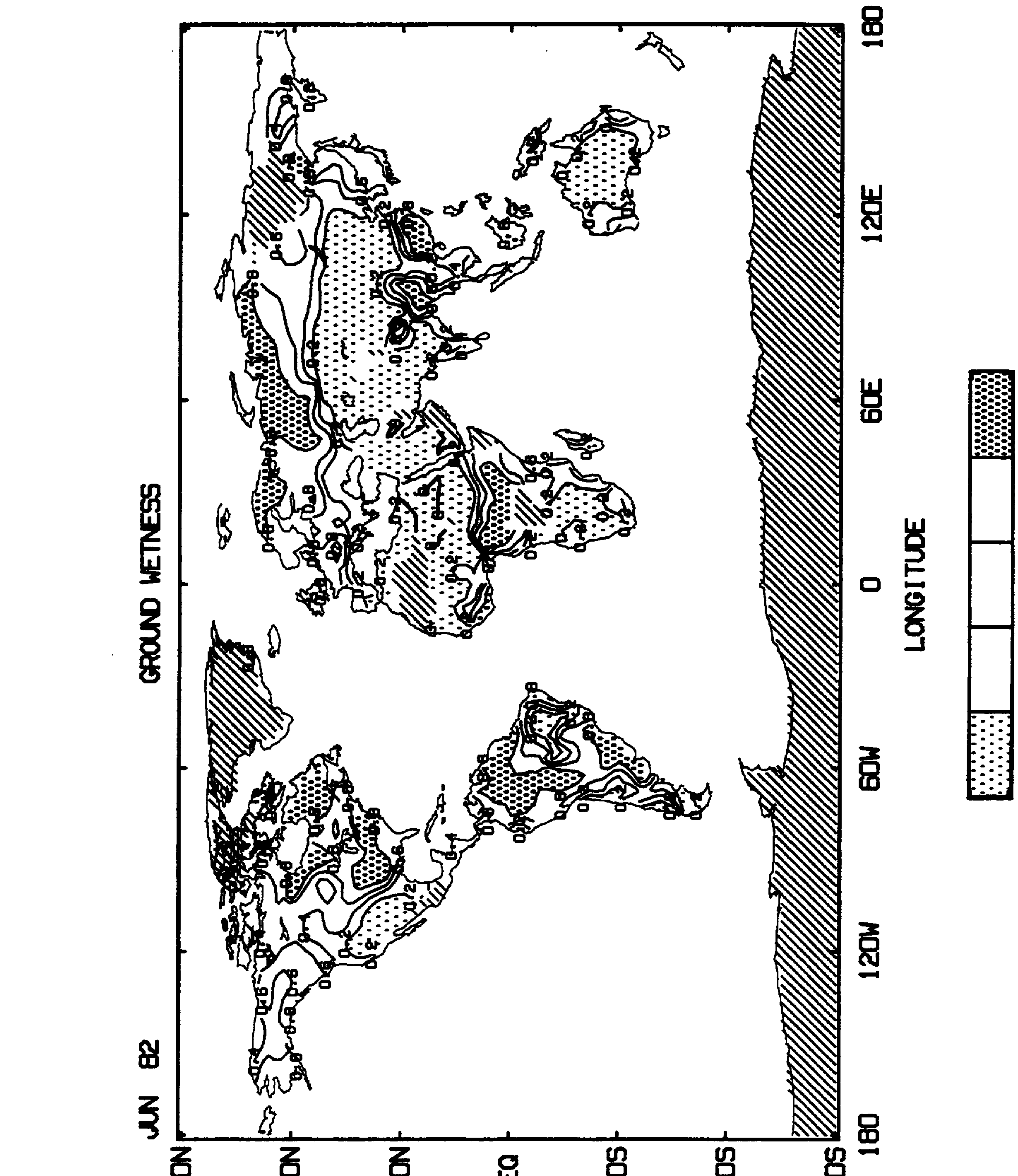
GROUND WETNESS
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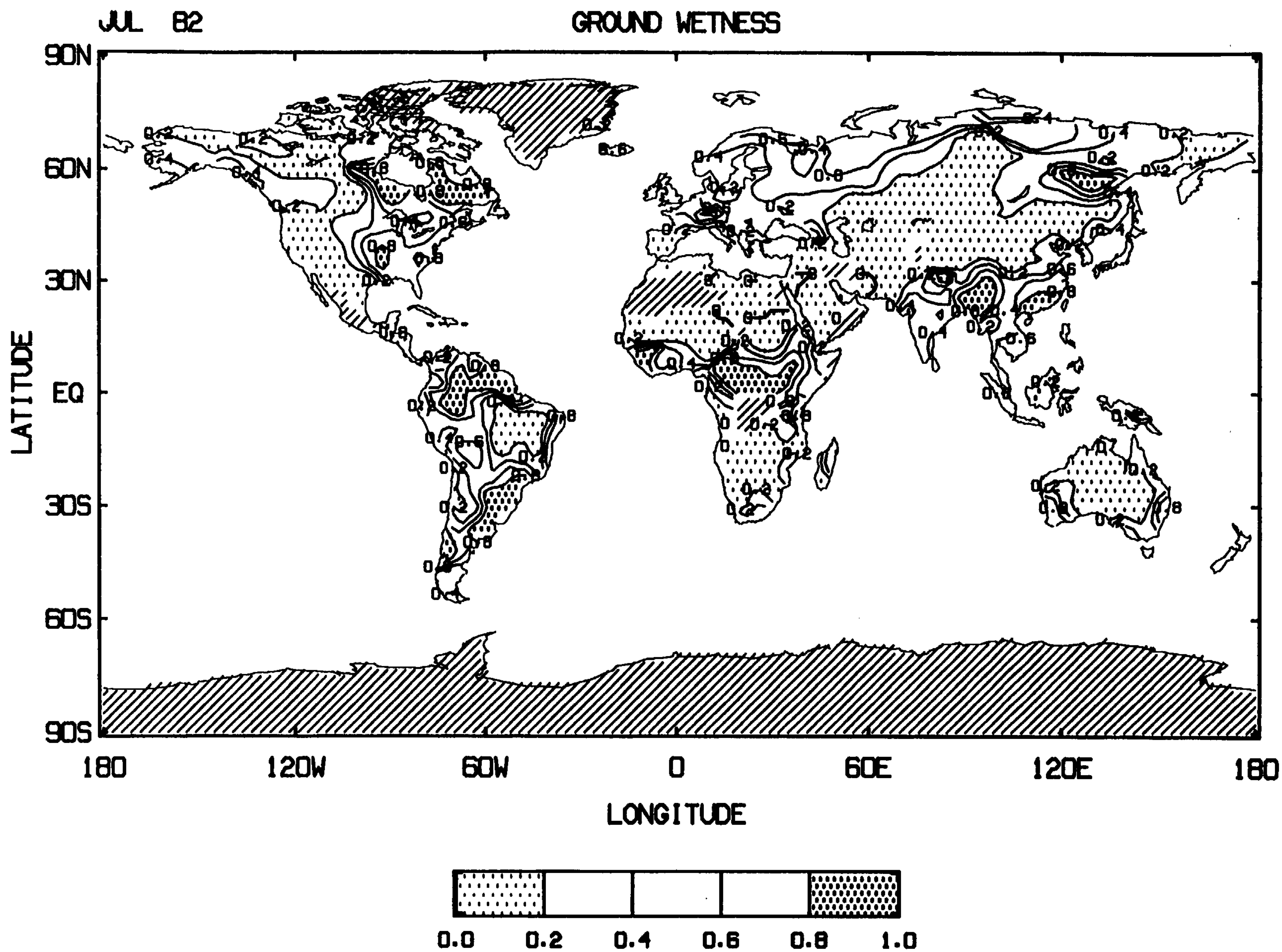
JUL 82
GROUND WETNESS
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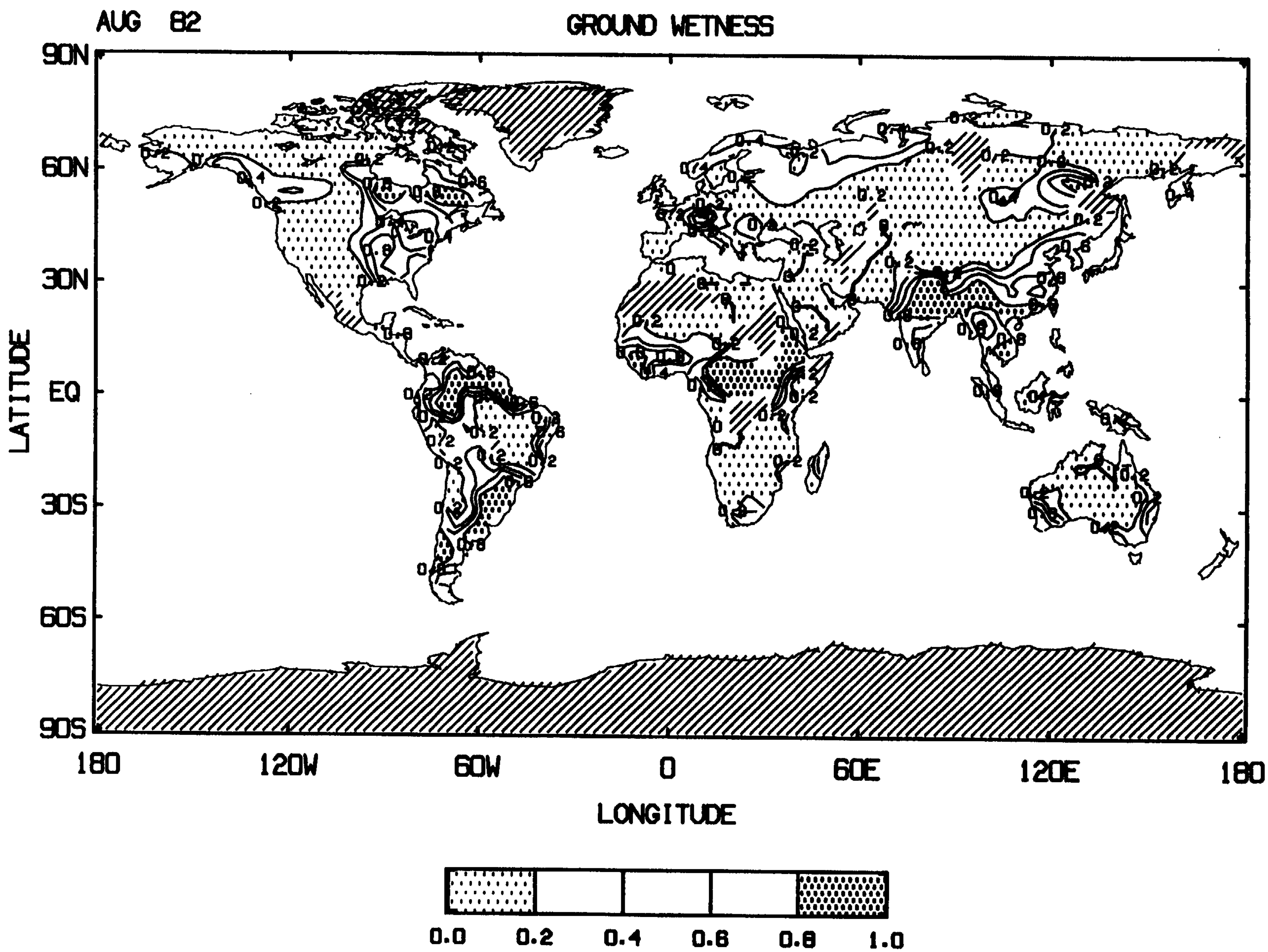
AUG 82
GROUND WETNESS
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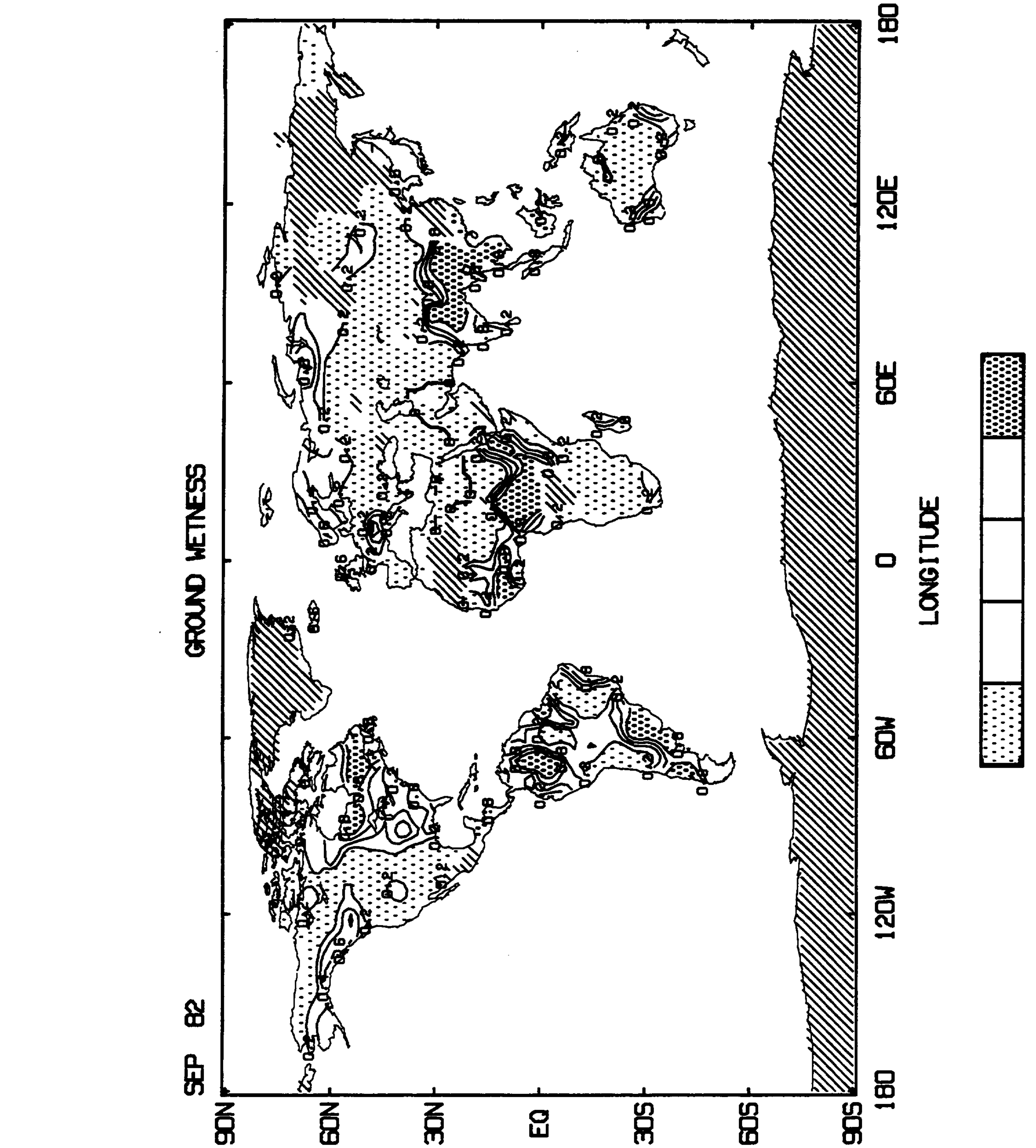

SEP 82
GROUND WETNESS
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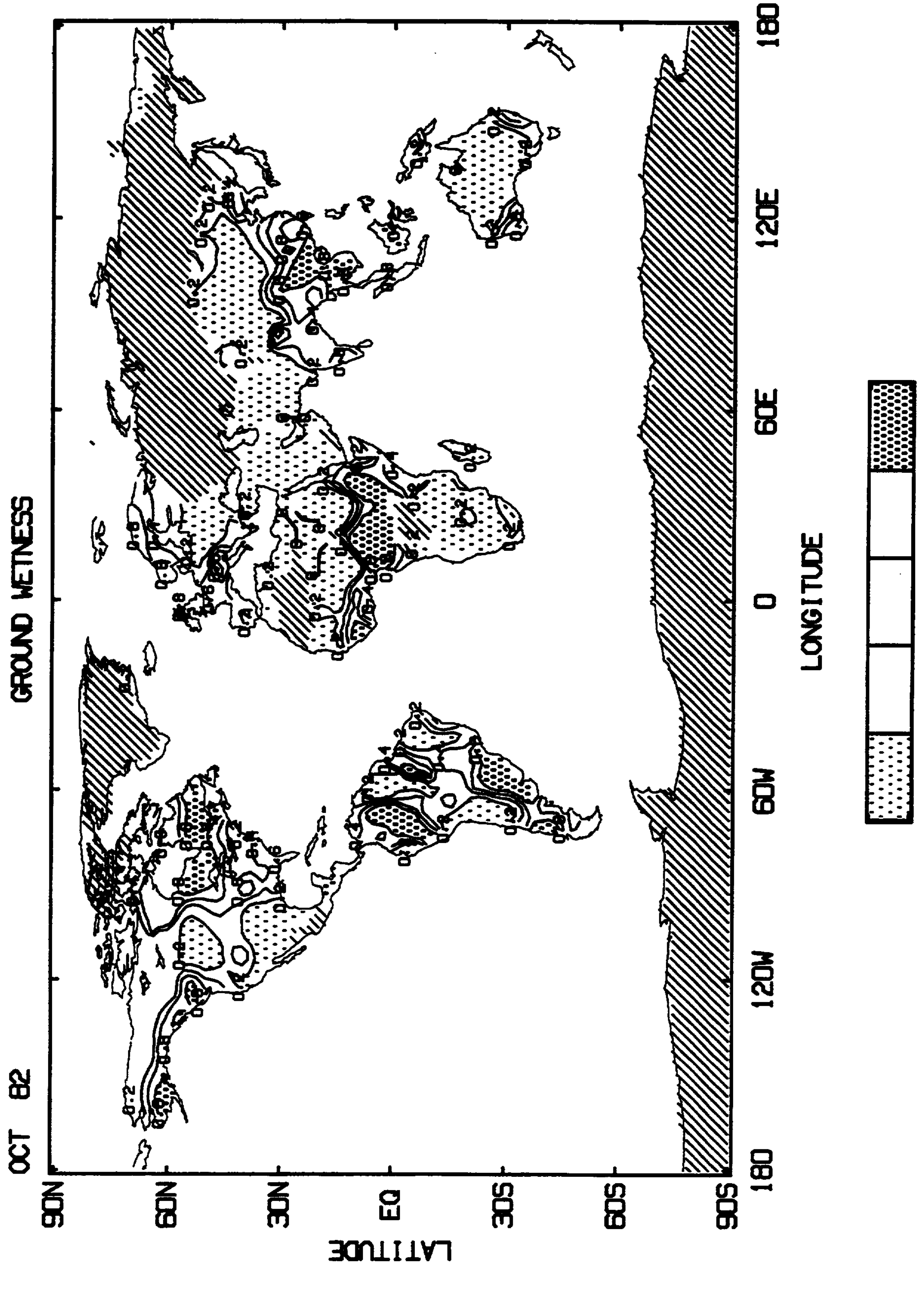

OCT 82
GROUND WETNESS
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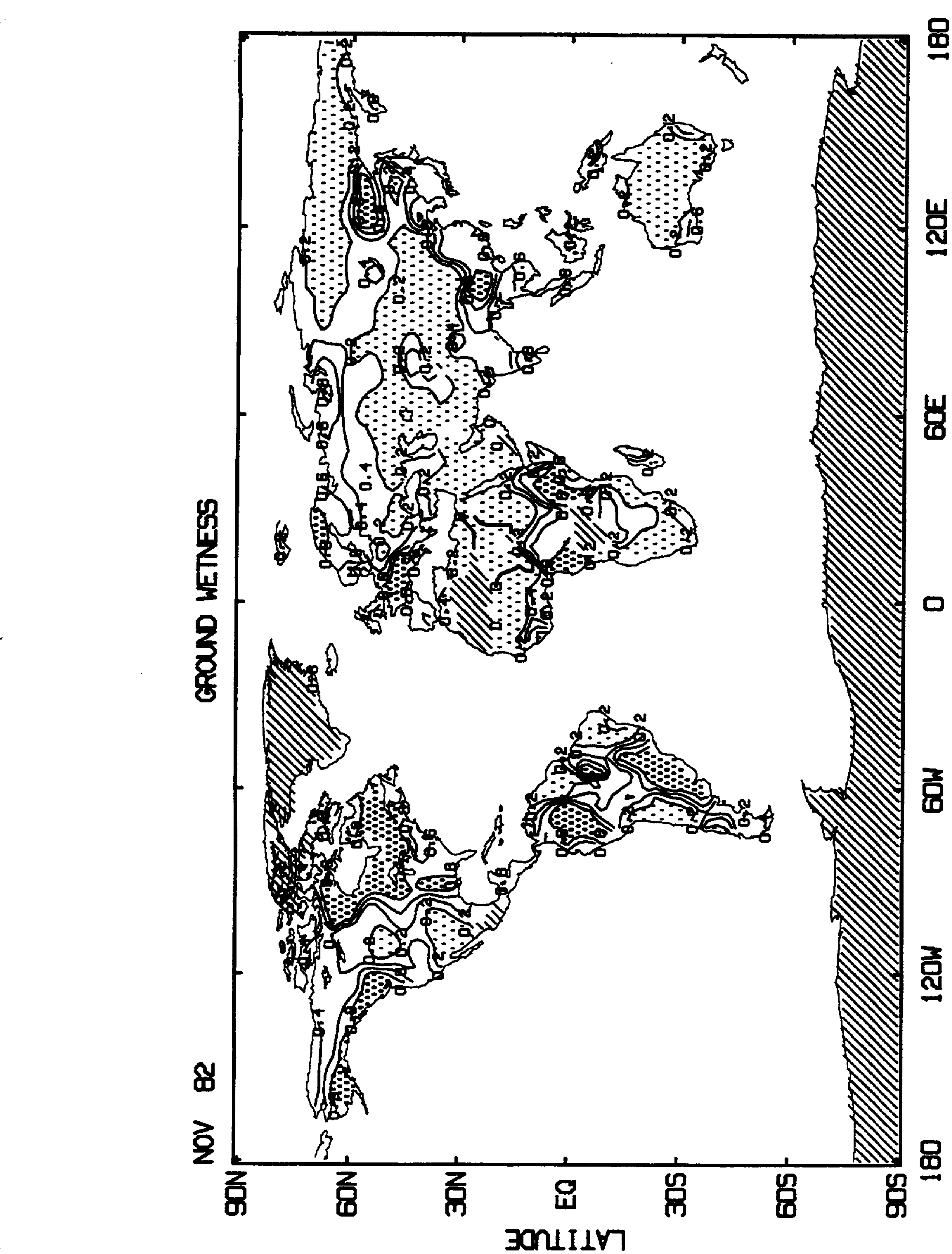
NOV 82
GROUND WETNESS
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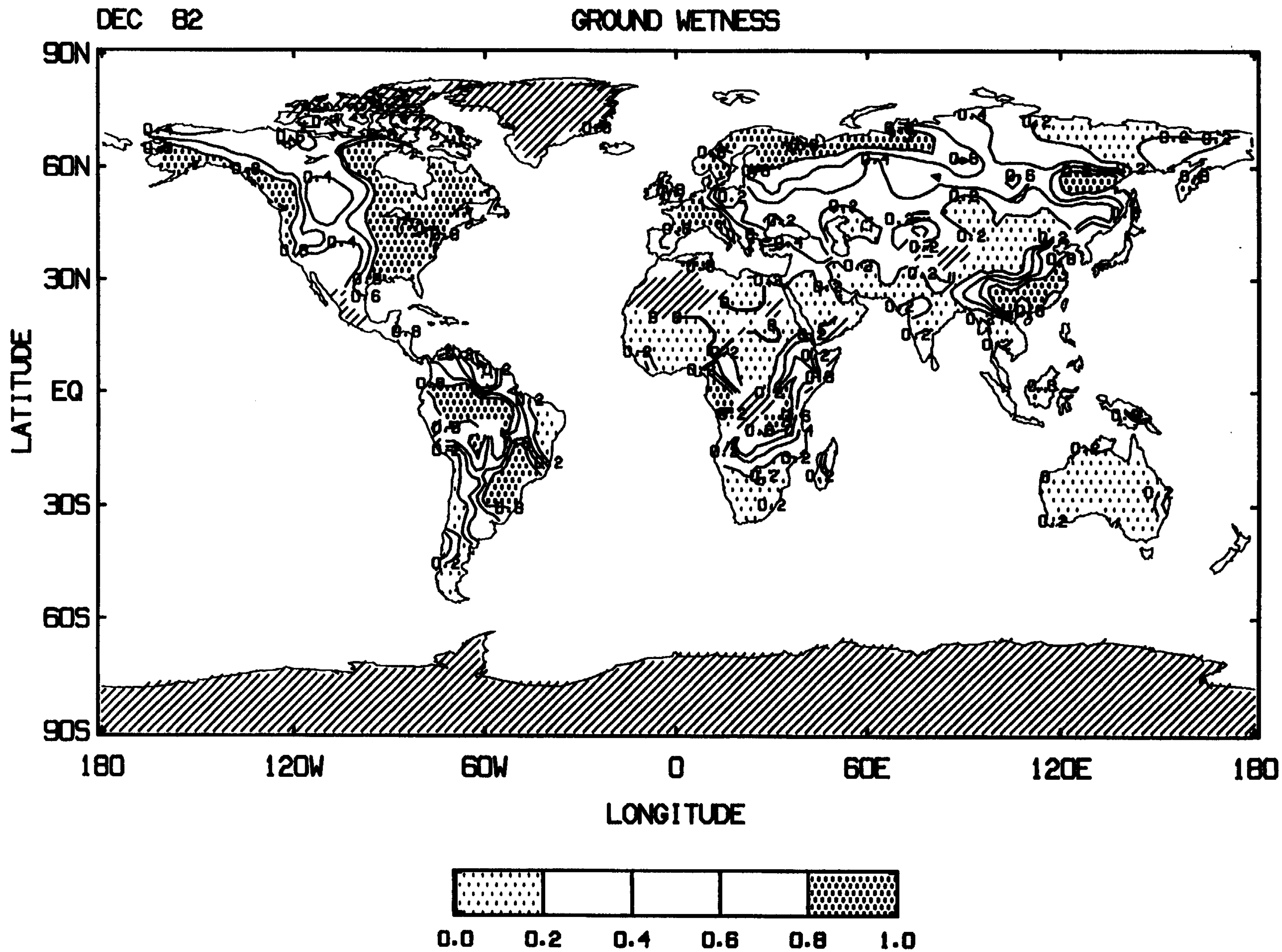

DEC 82
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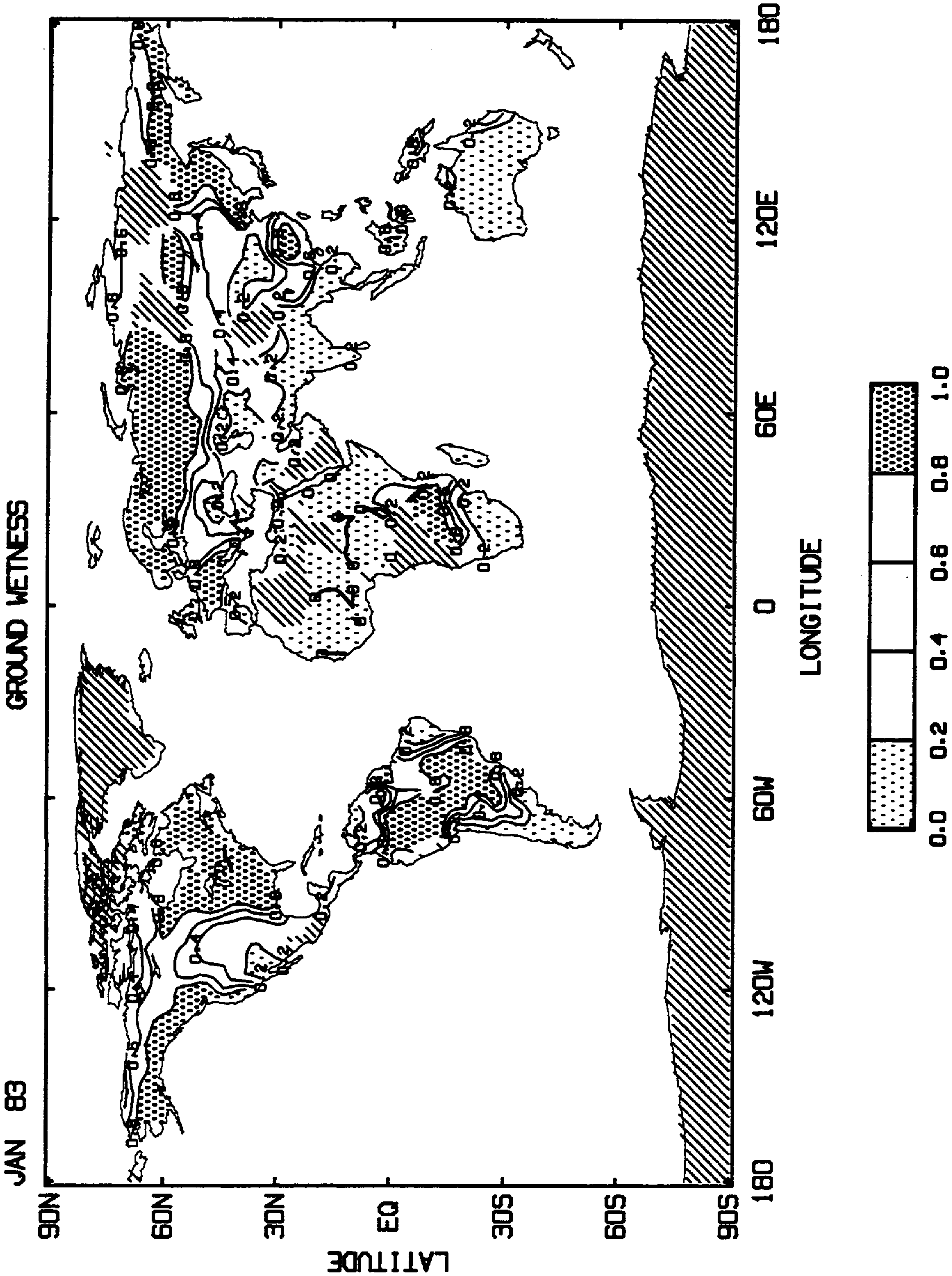
<u>1983</u>


GROUND WETNESS
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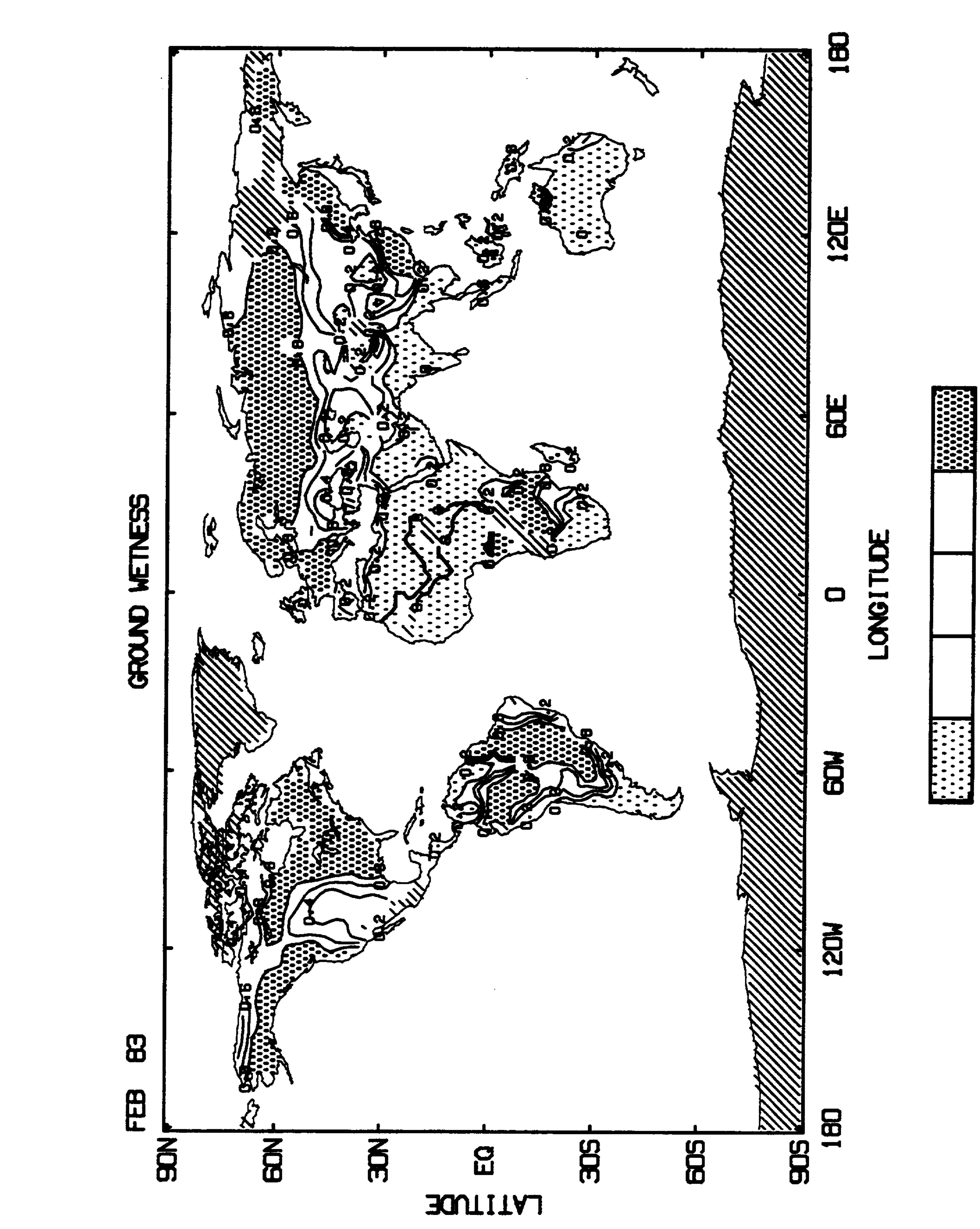
FEB 83
GROUND WETNESS
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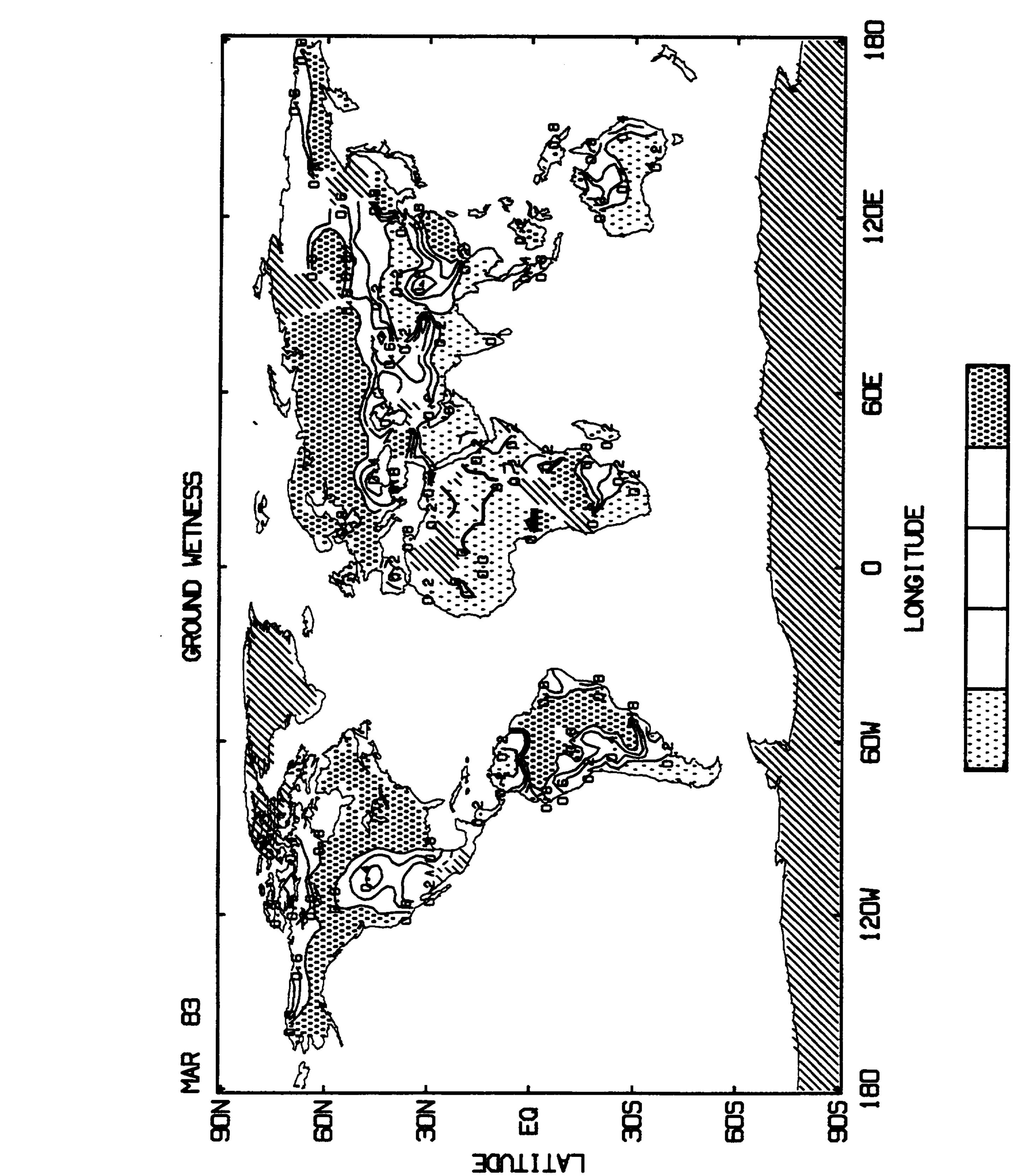

MAR 83
GROUND WETNESS
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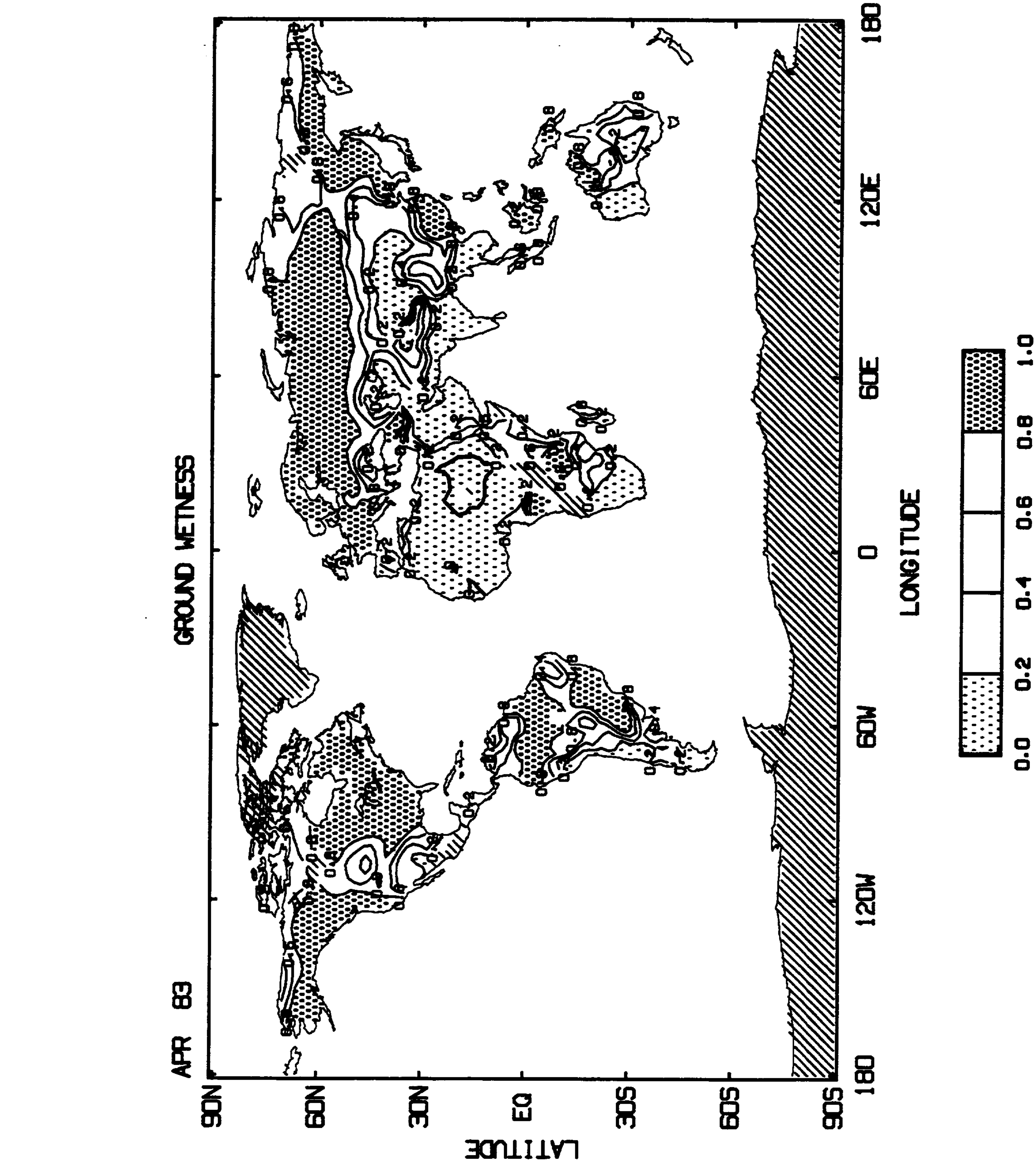
APR 83
GROUND WETNESS
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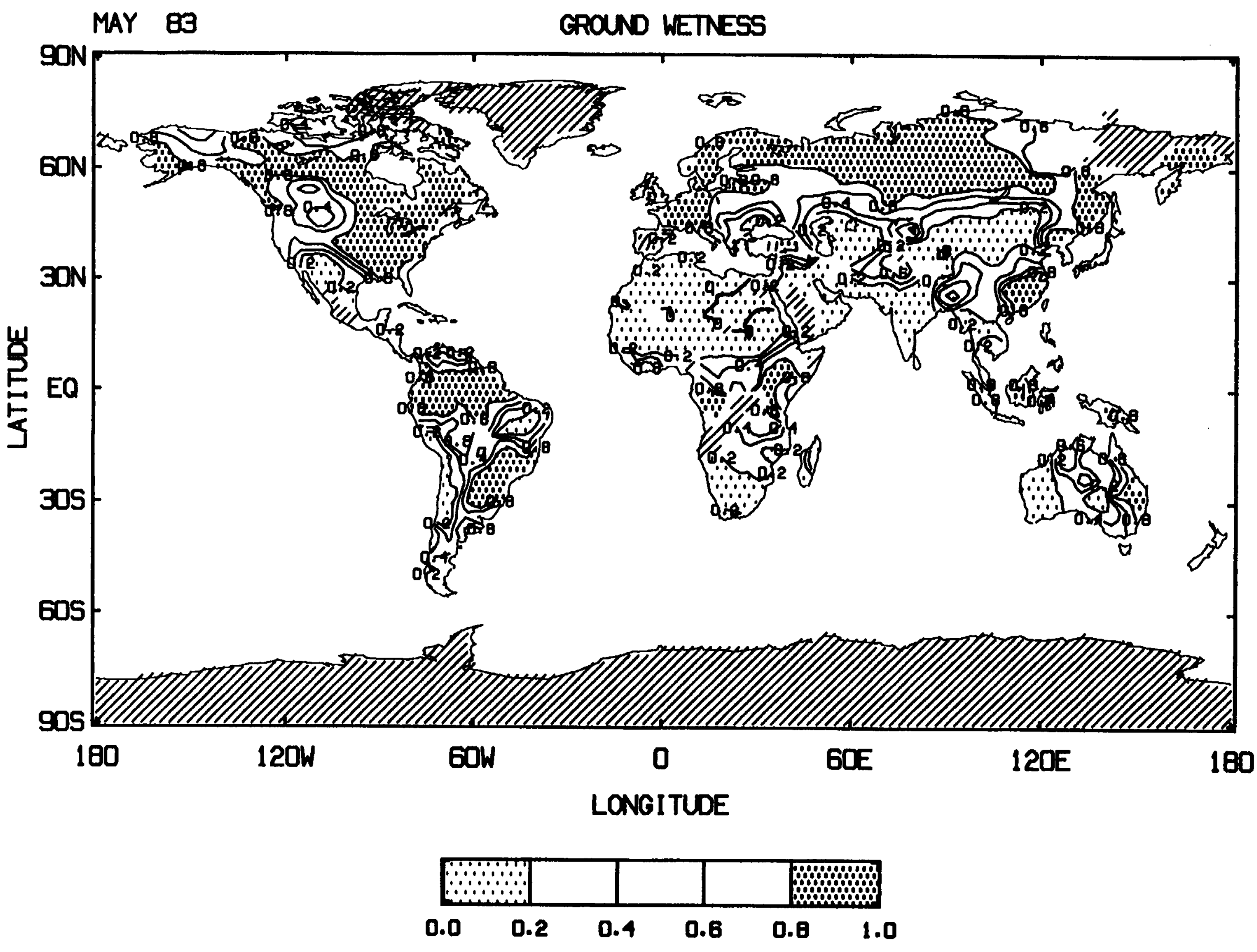

MAY 83
GROUND WETNESS
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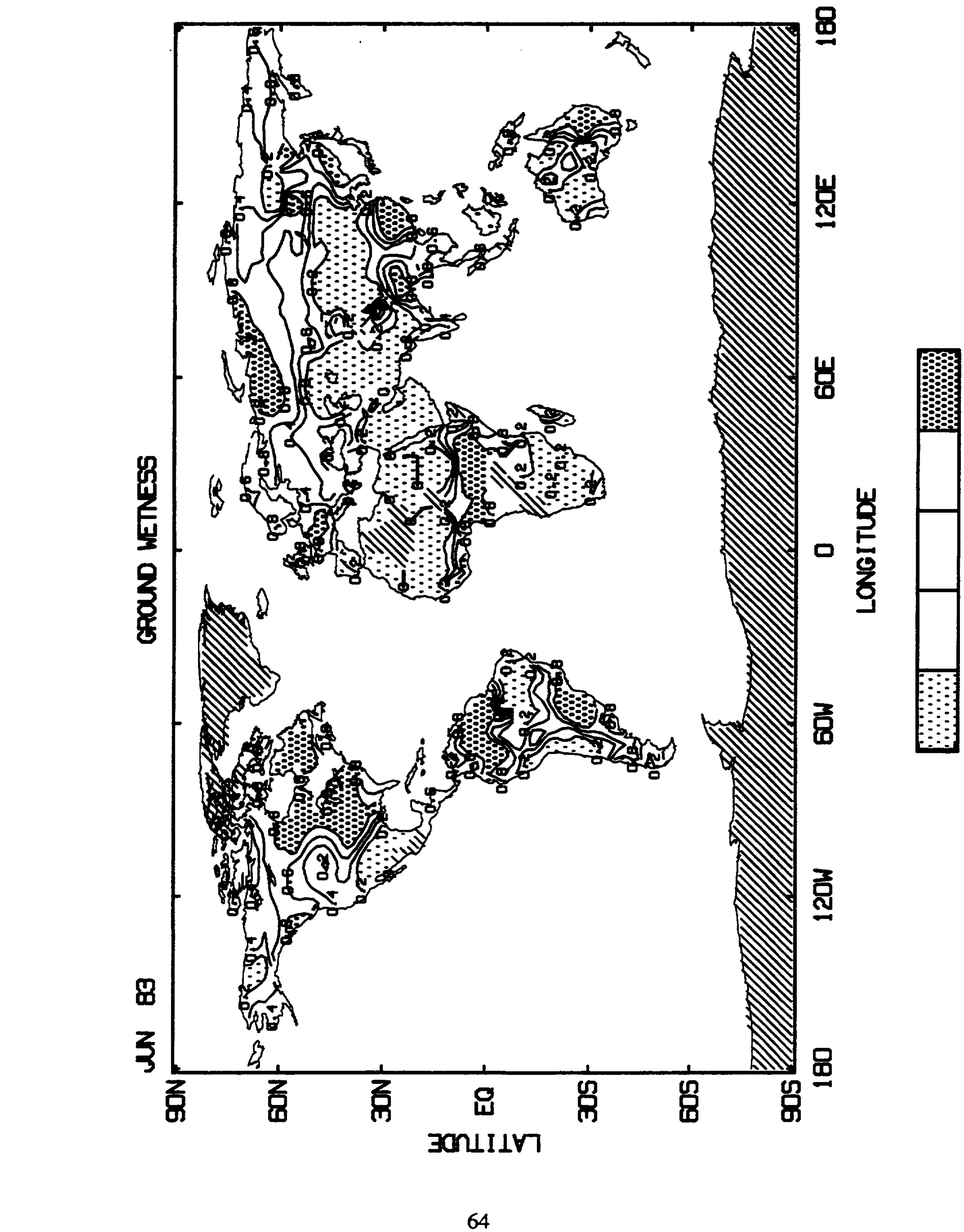

JUN 83
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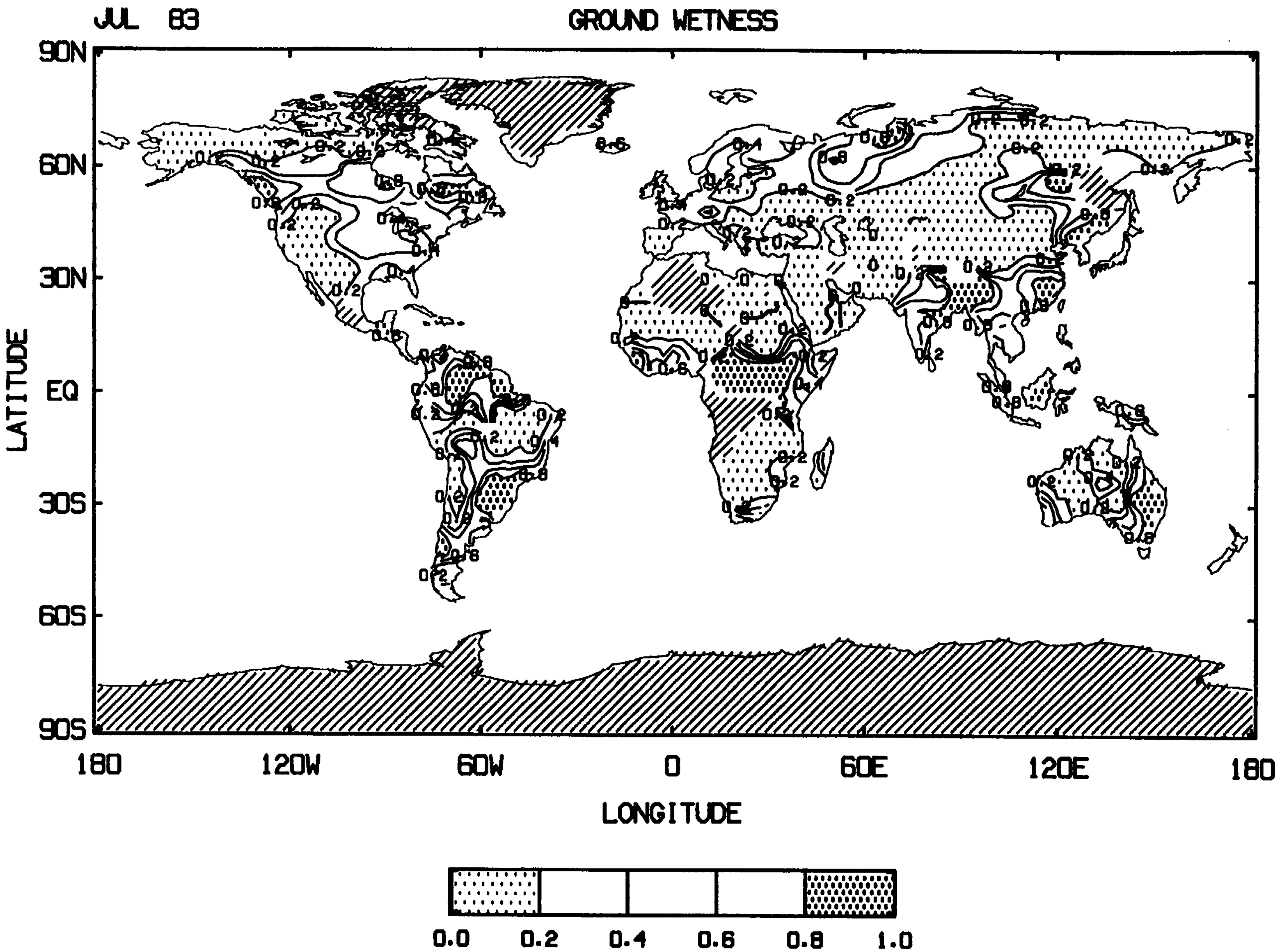
JUL 83
GROUND WETNESS
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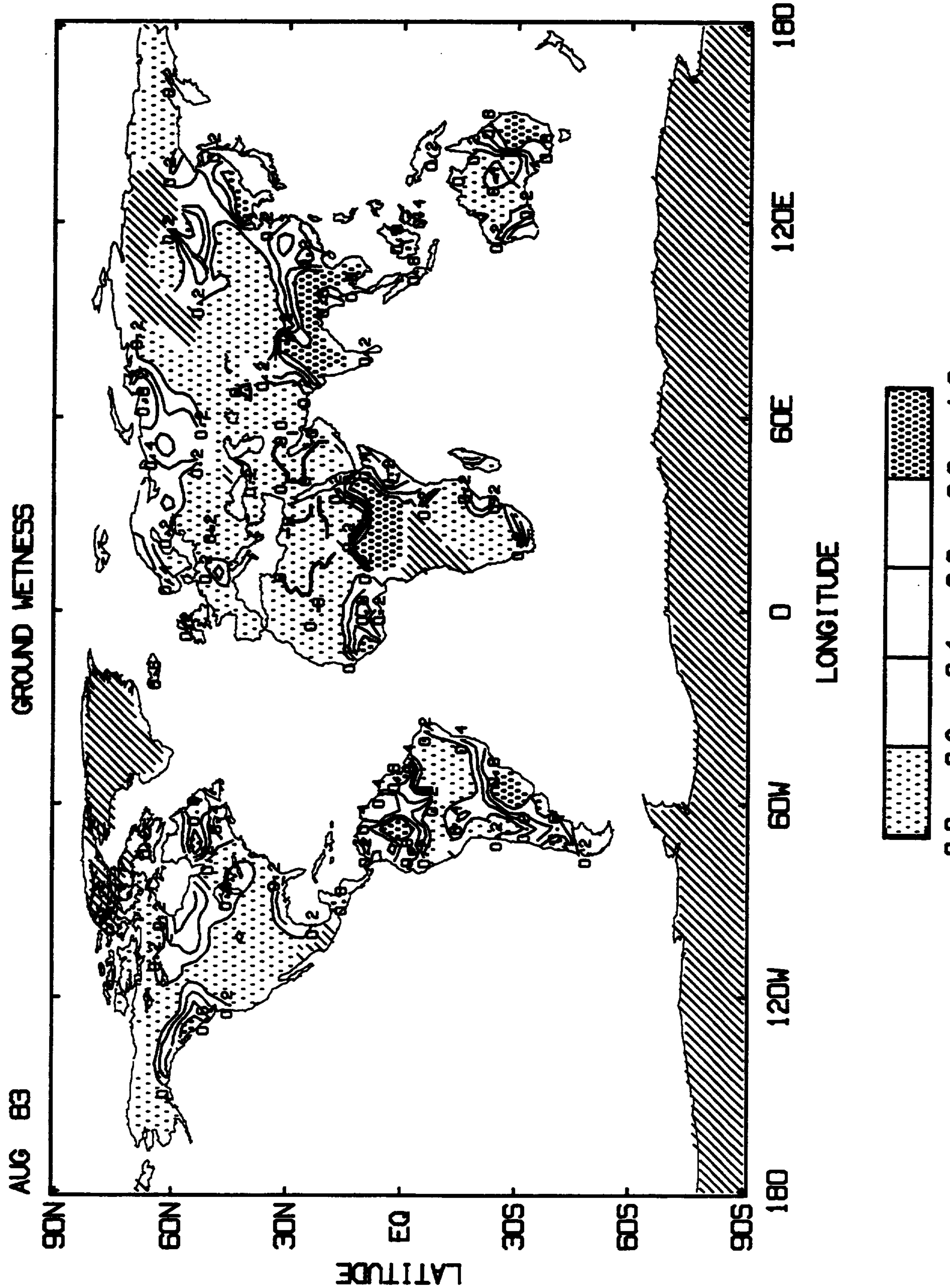
AUG 83
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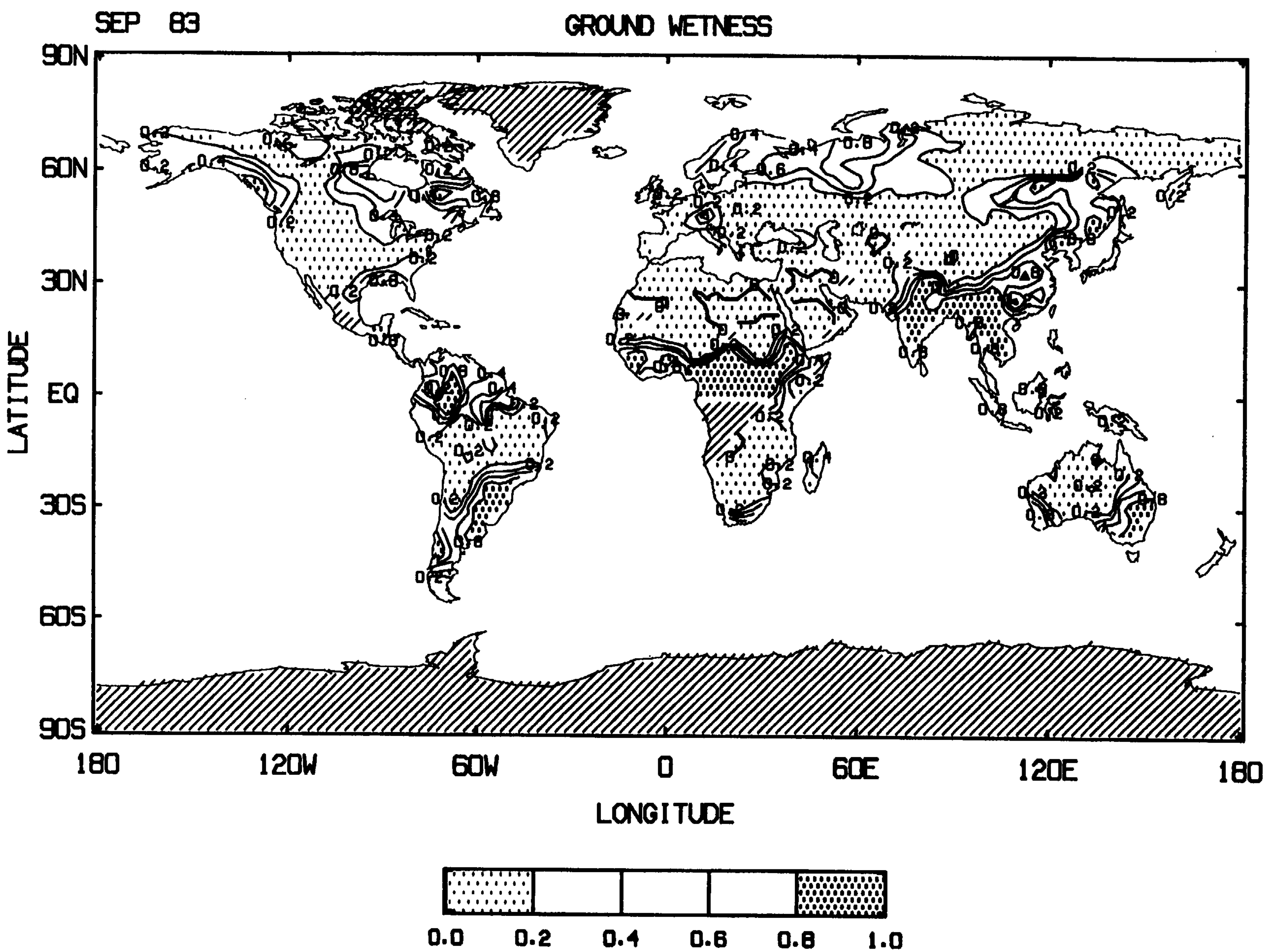
SEP 83
GROUND WETNESS
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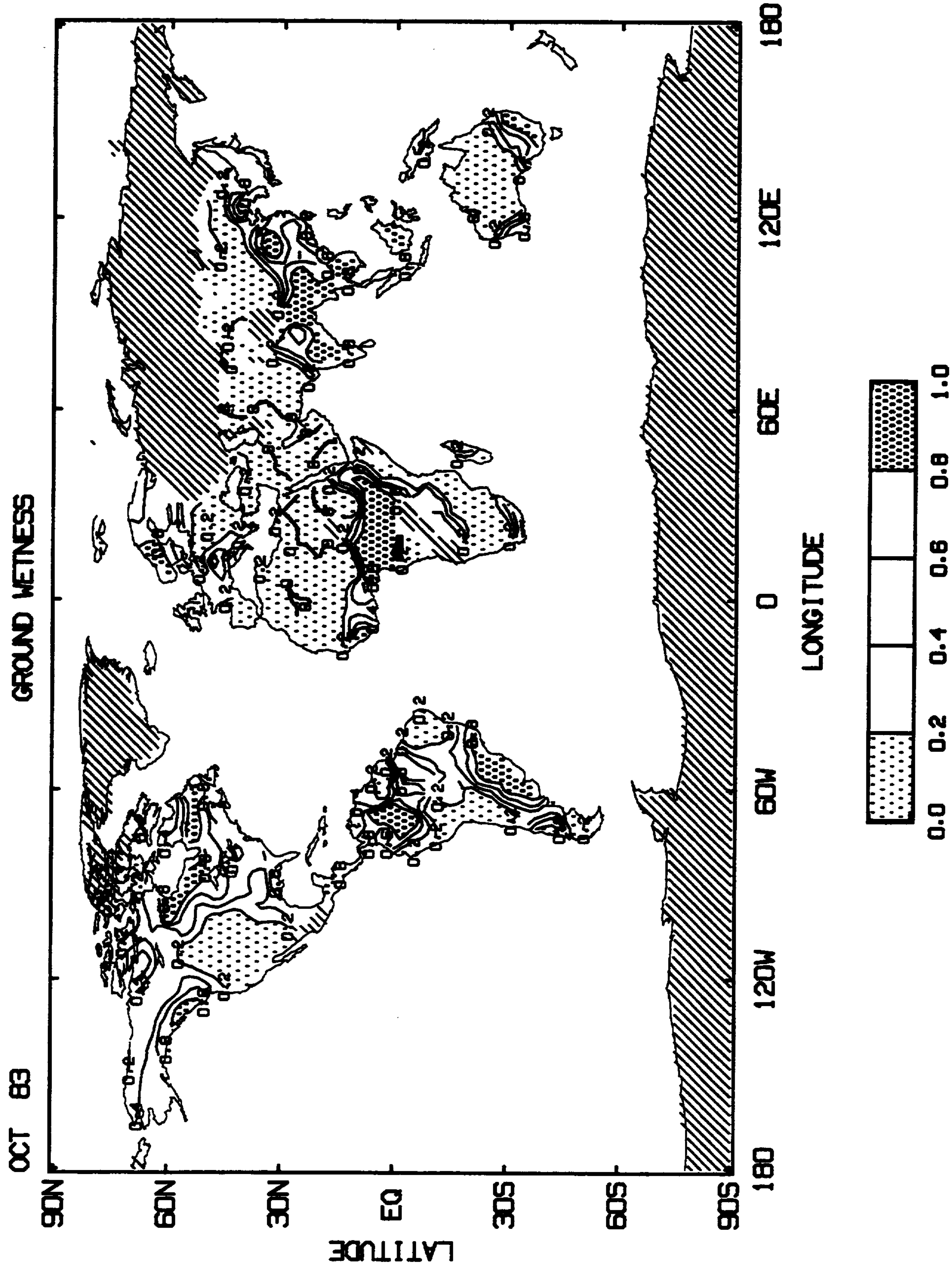

OCT 83
GROUND WETNESS
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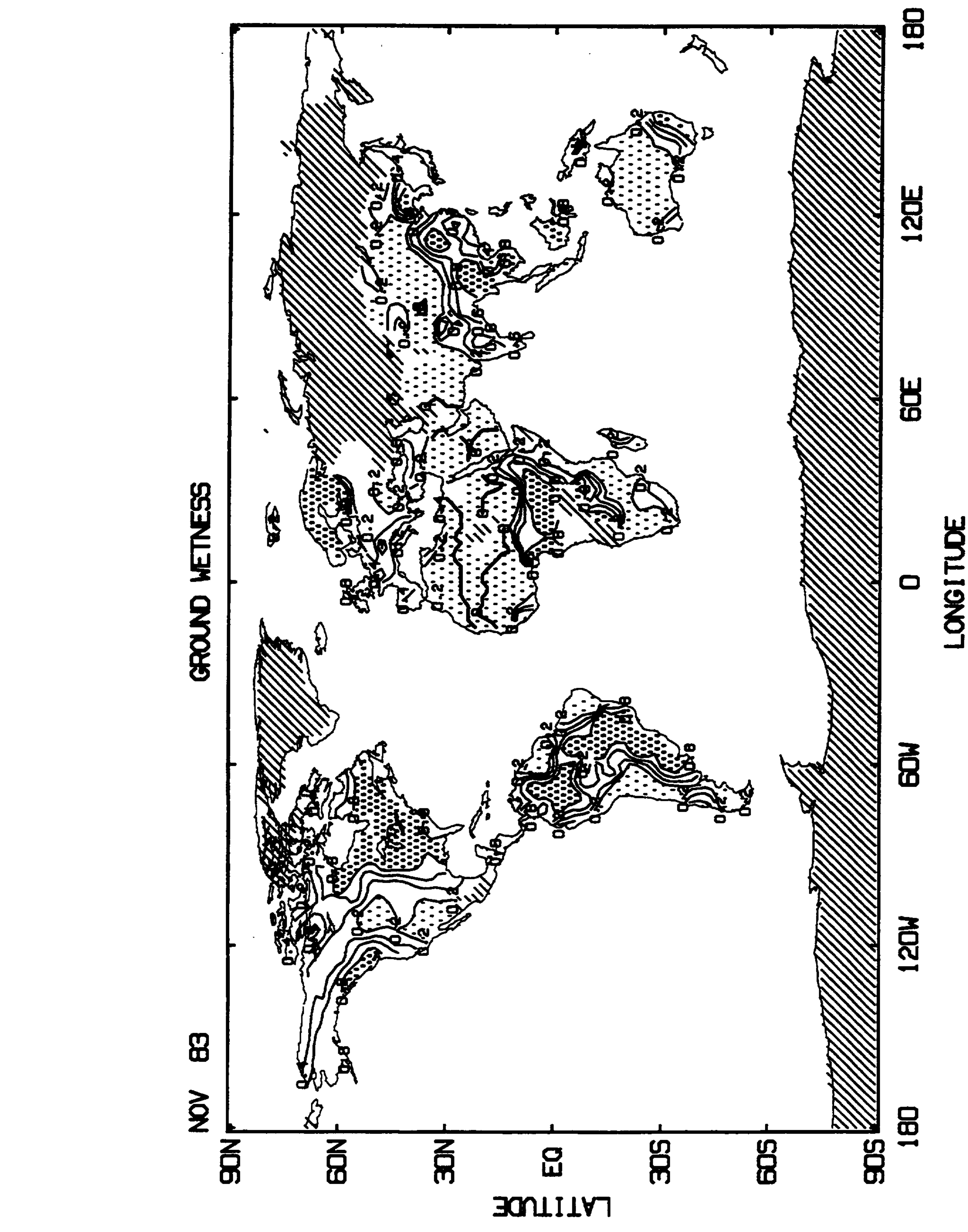
NOV 83
GROUND WETNESS
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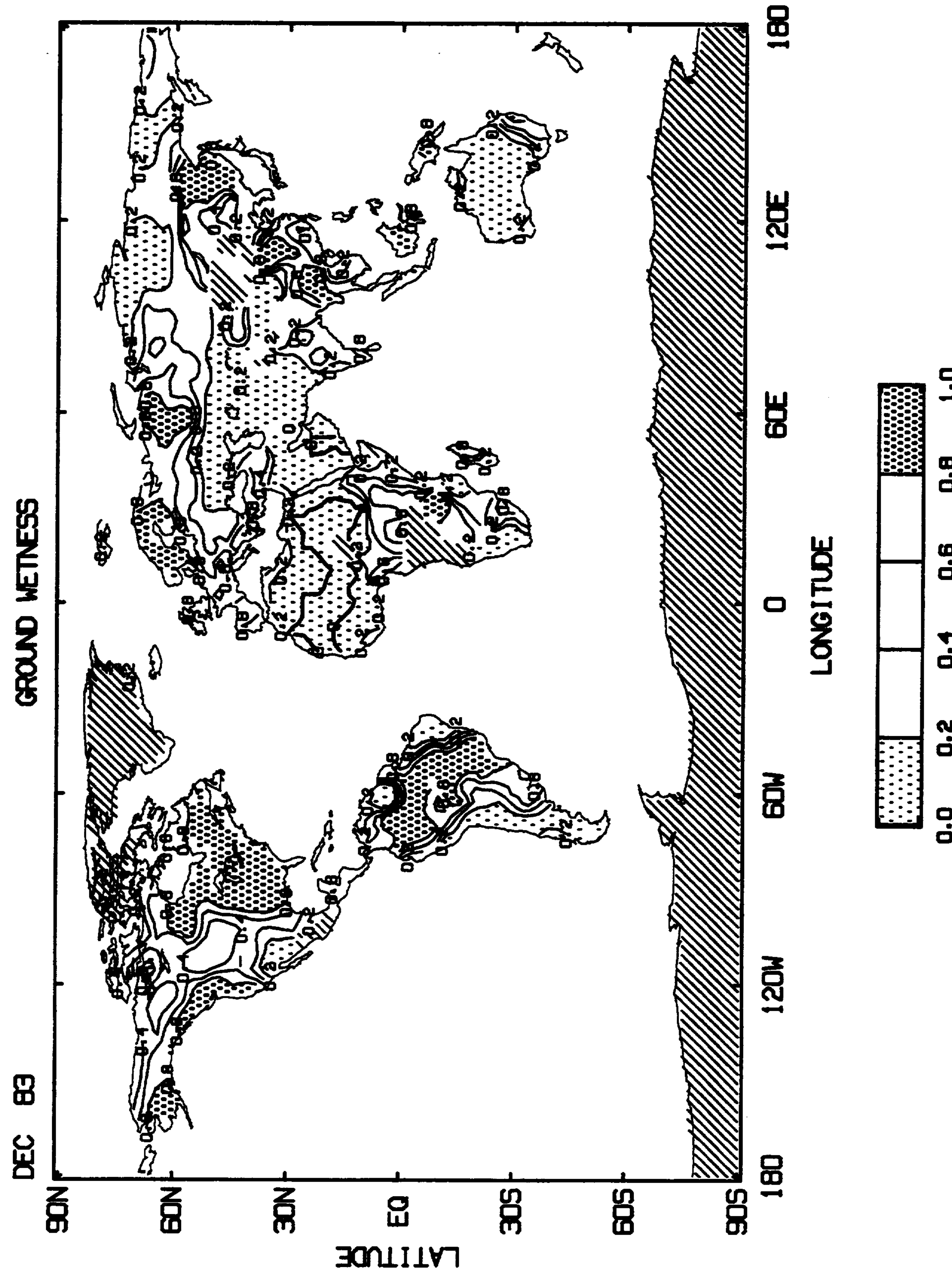
DEC 83
GROUND WETNESS
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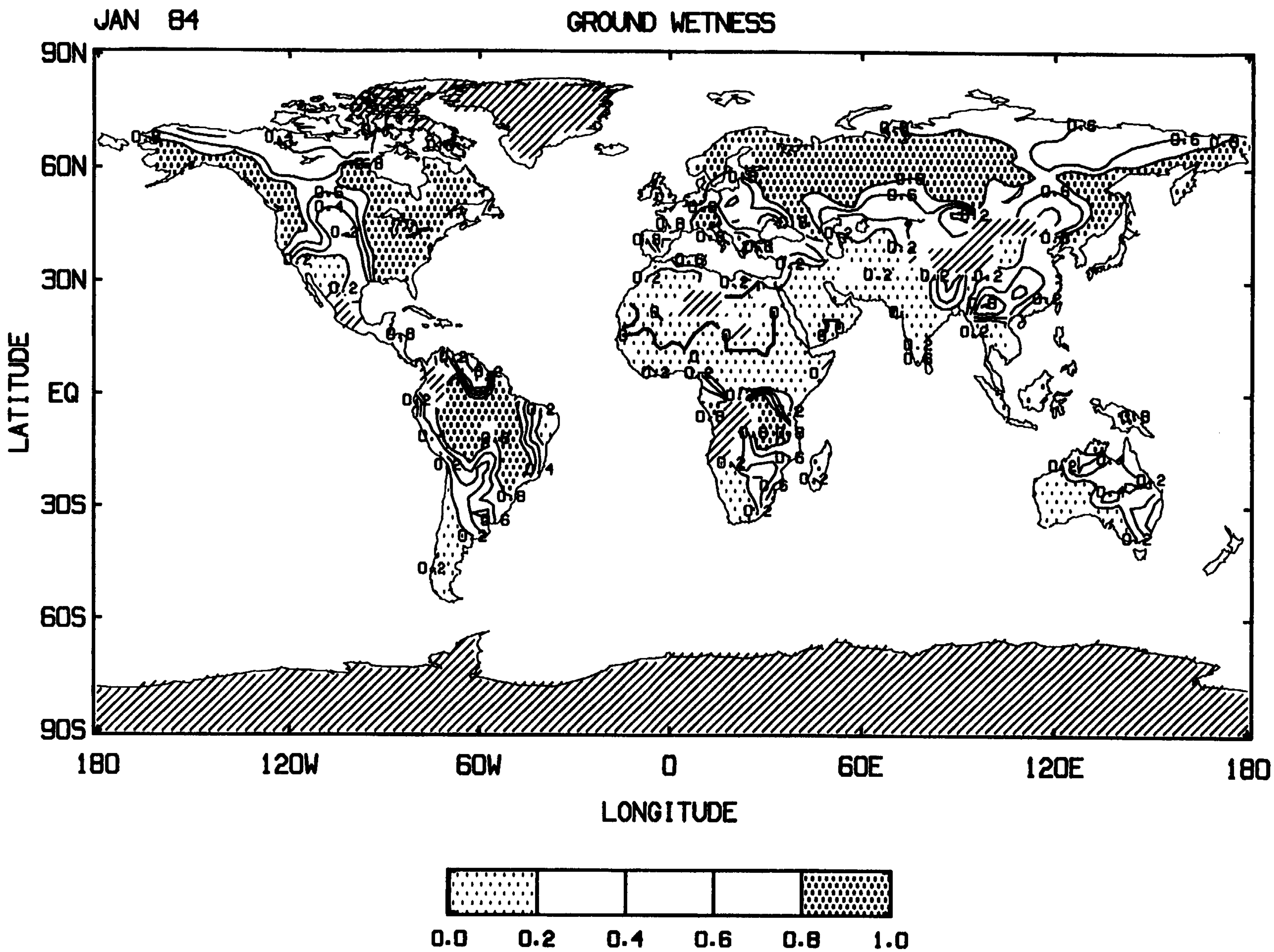
1984


JAN 84
GROUND WETNESS
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EQ
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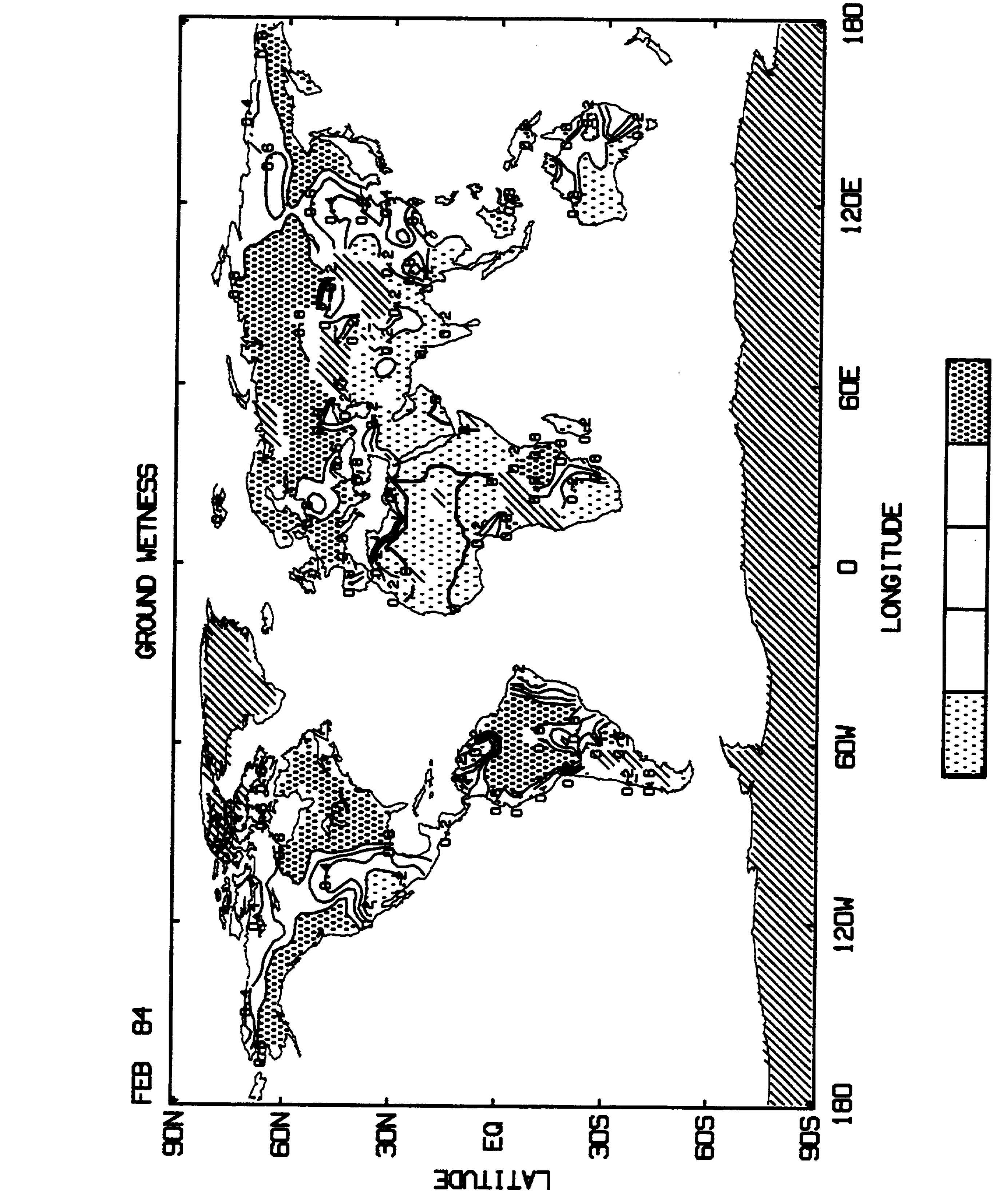
1.0


FEB 84
GROUND WETNESS
LATITUDE
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EQ
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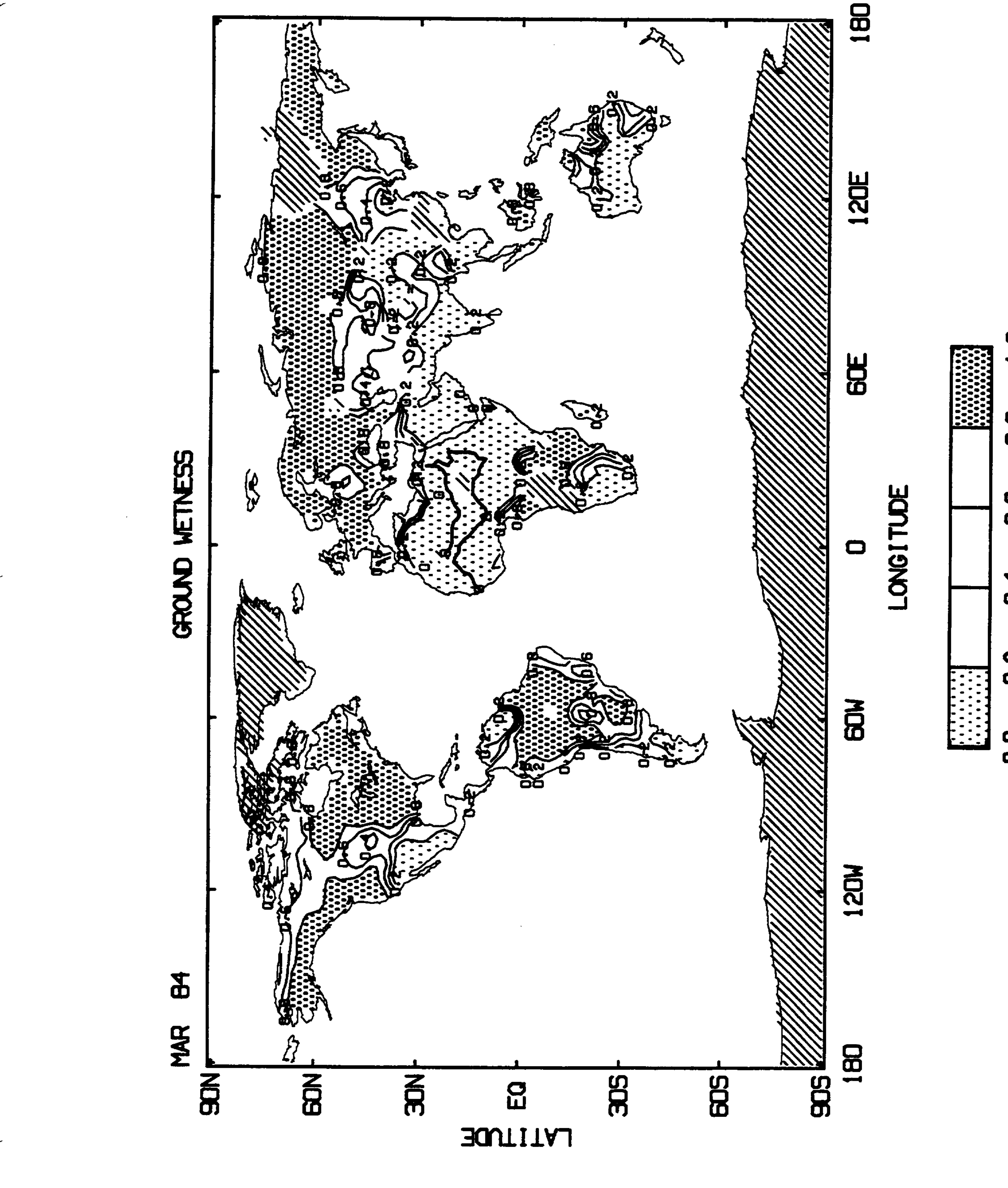

GROUND WETNESS
MAR 84
LATITUDE
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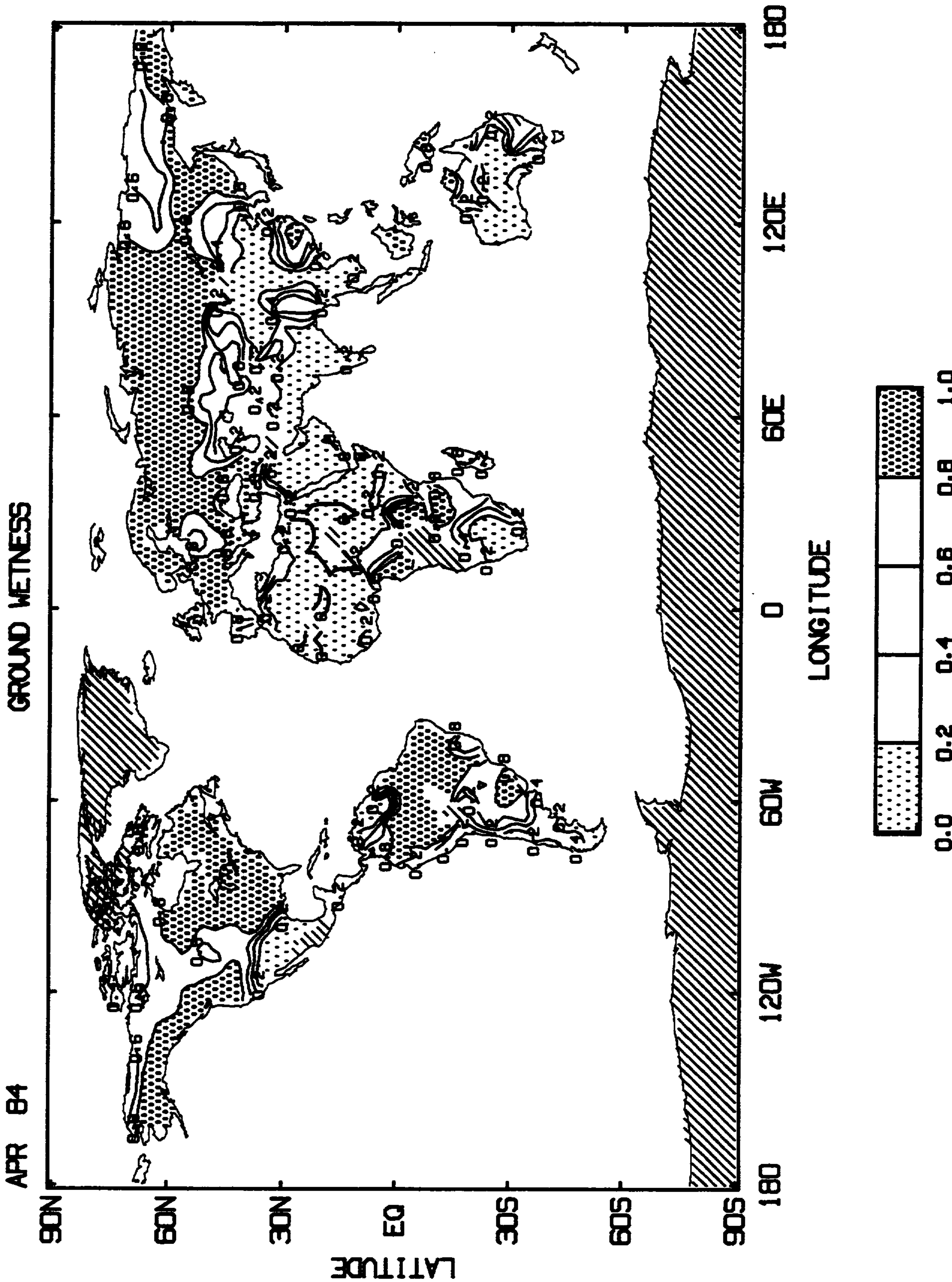

APR 84
GROUND WETNESS
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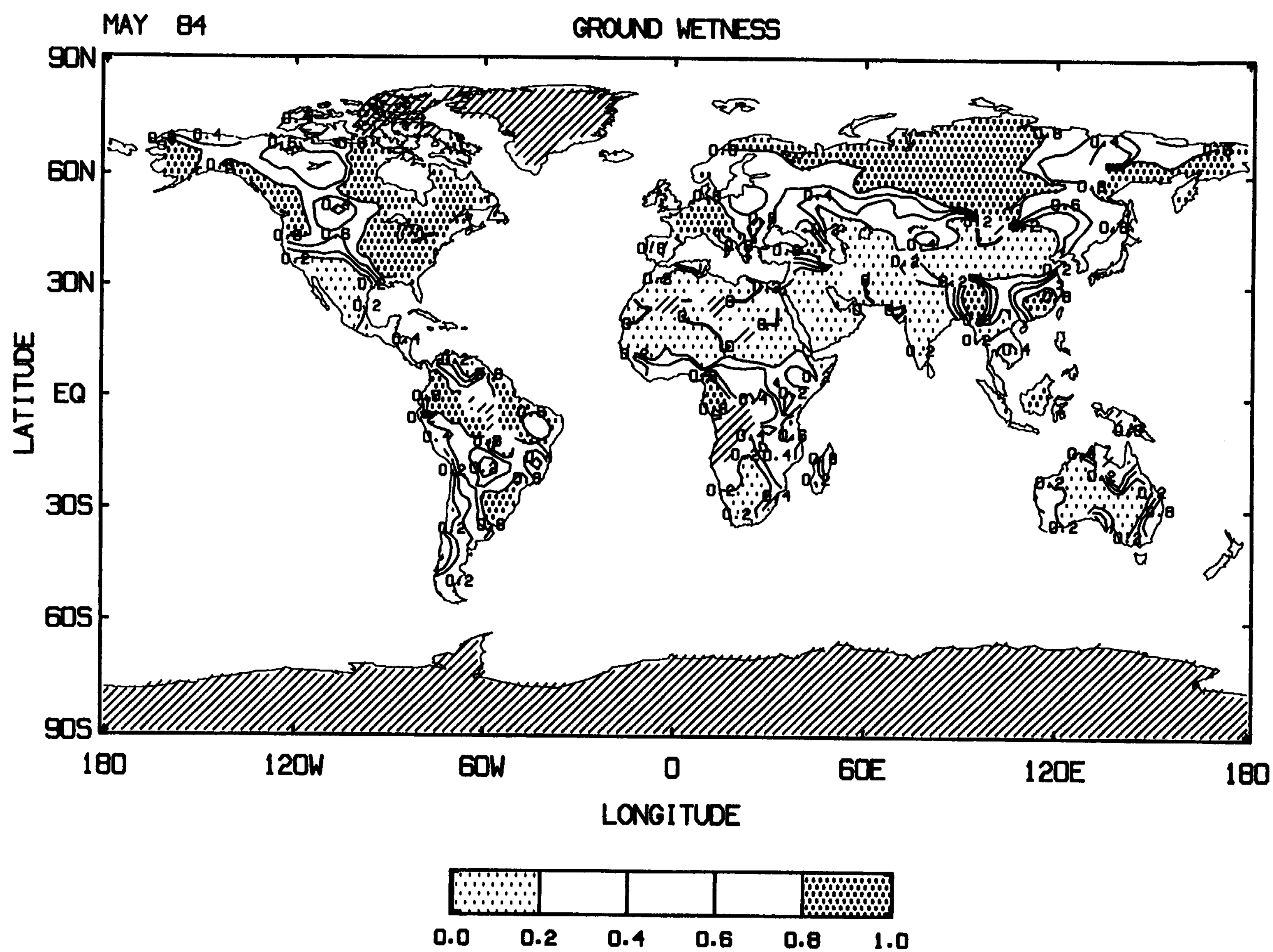

MAY 84
GROUND WETNESS
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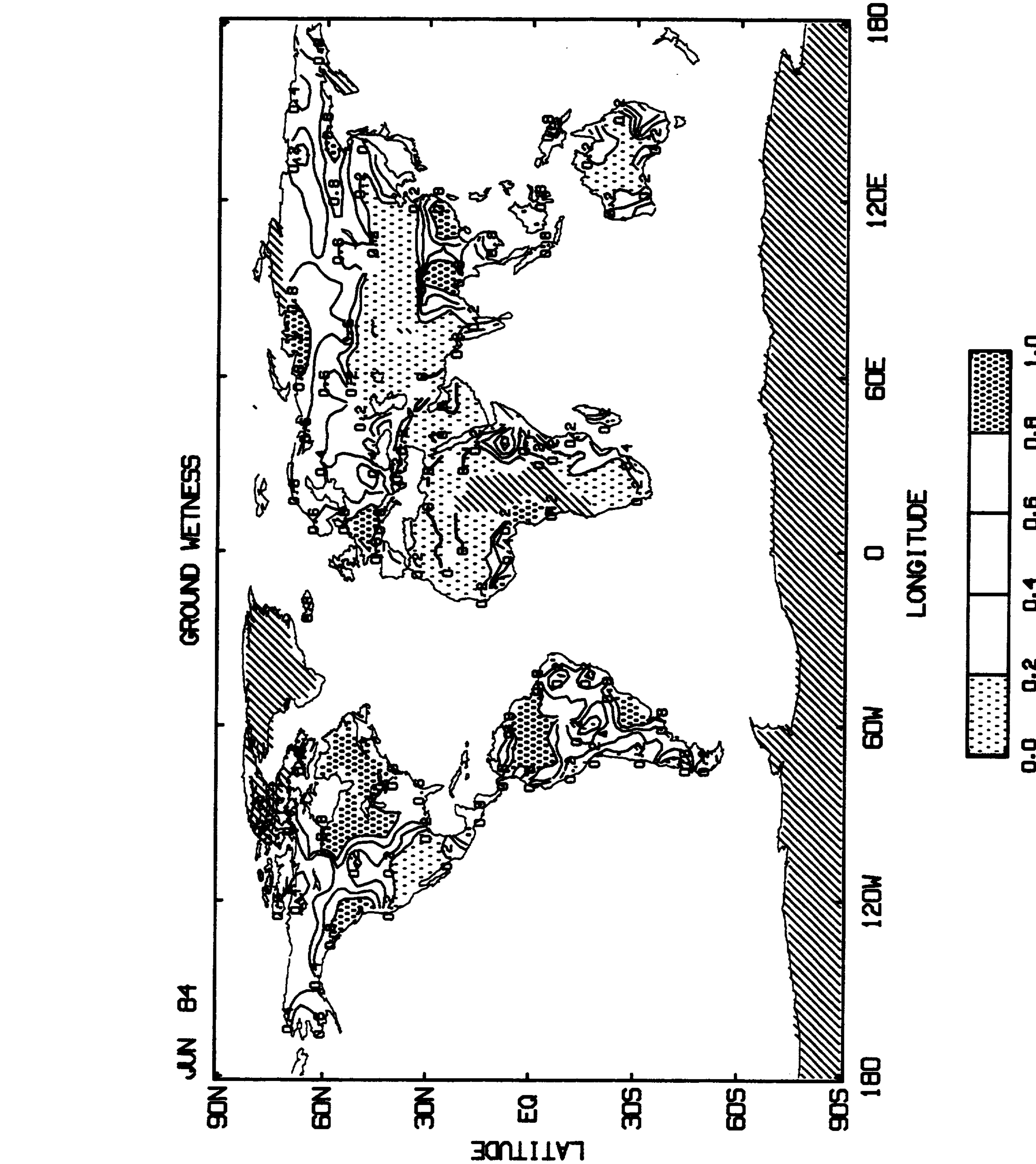

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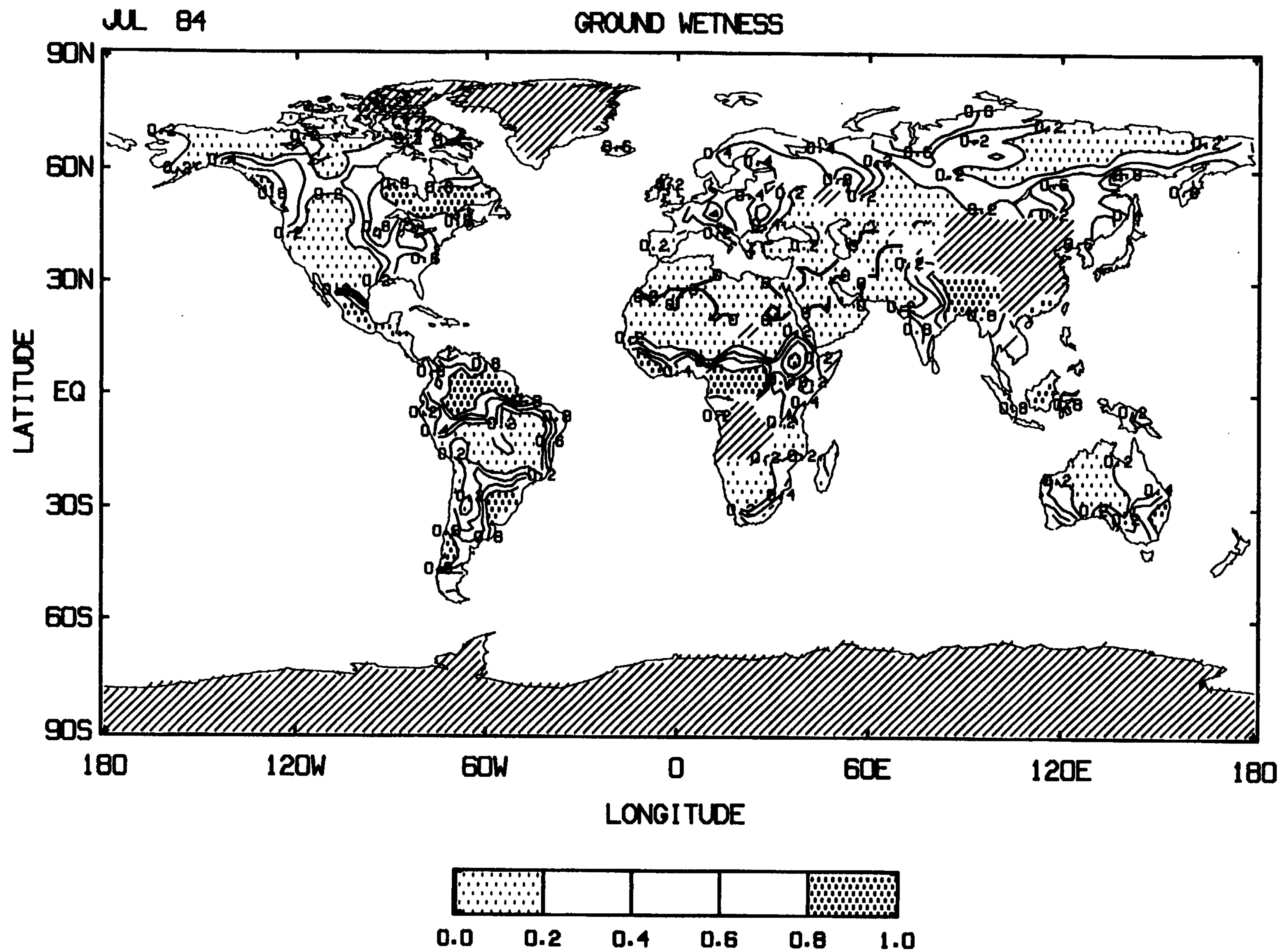
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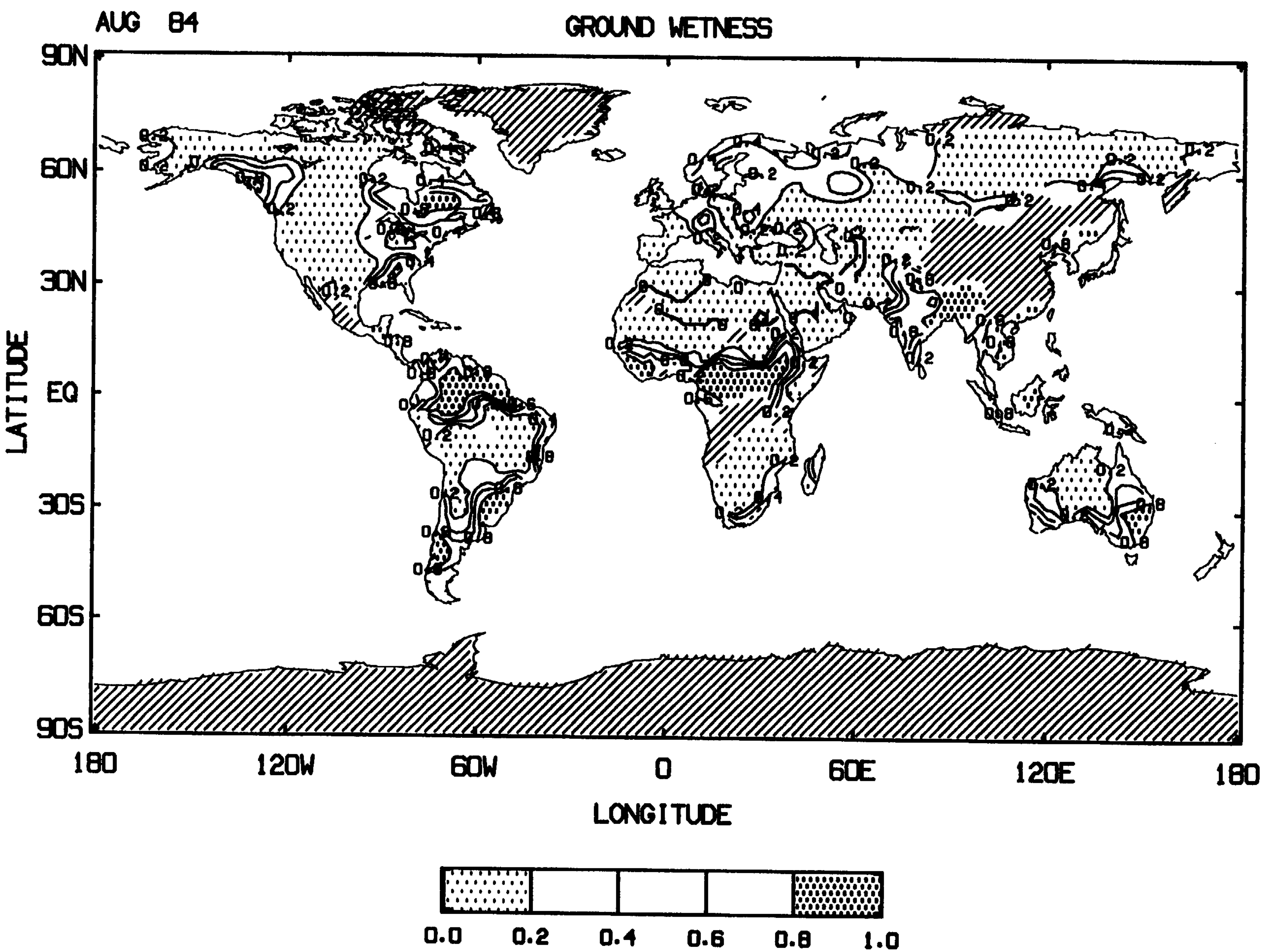
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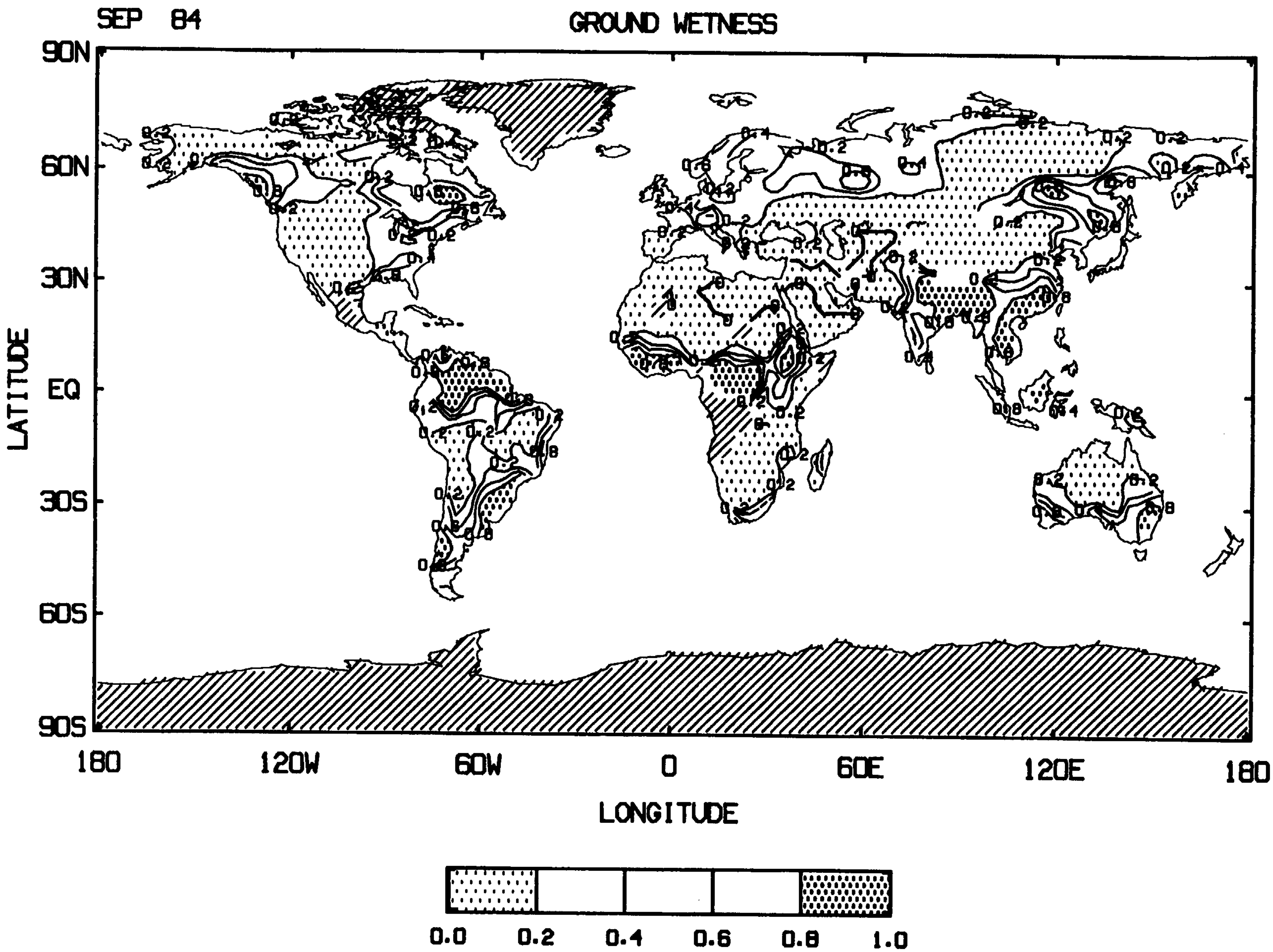
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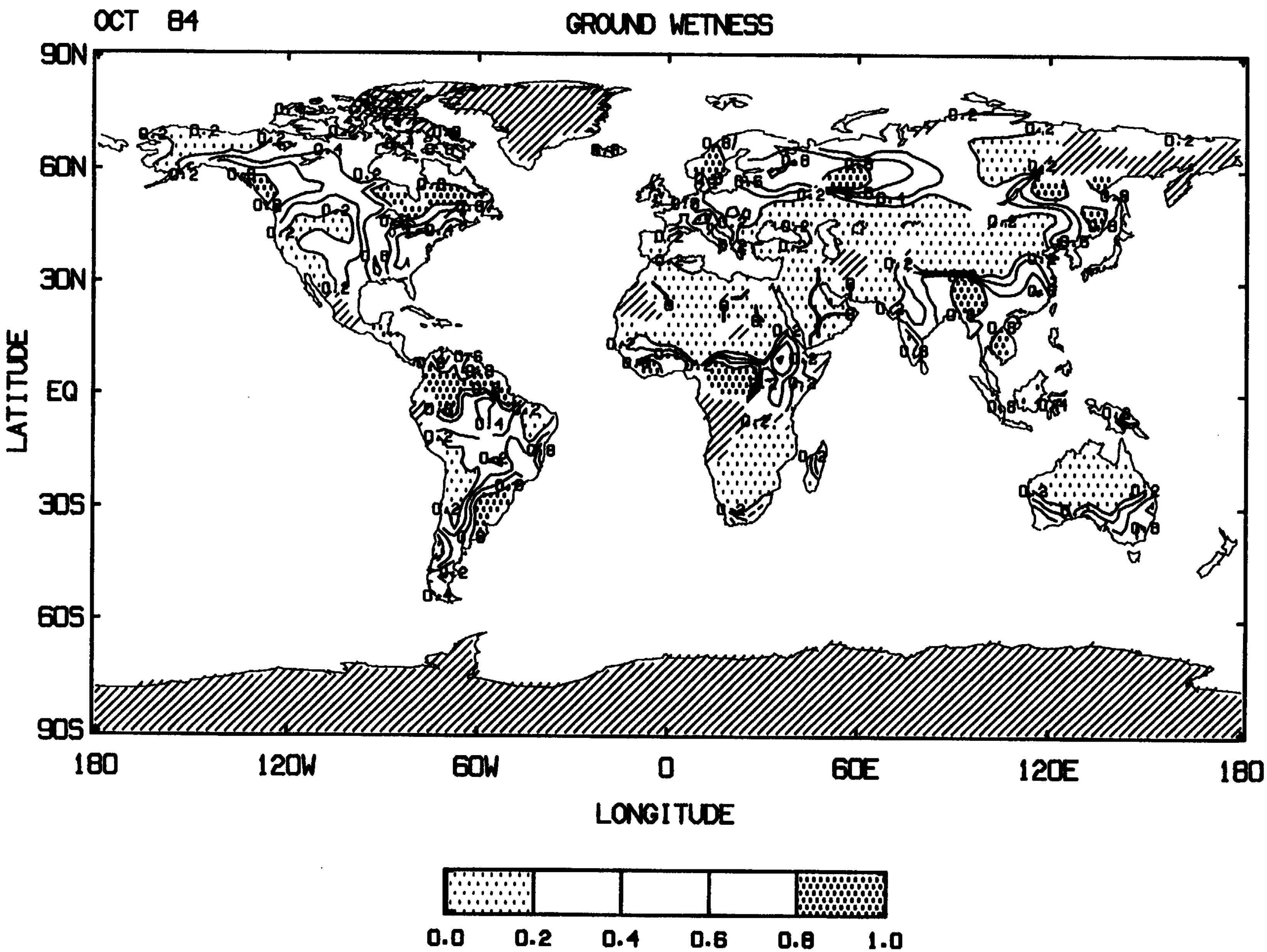
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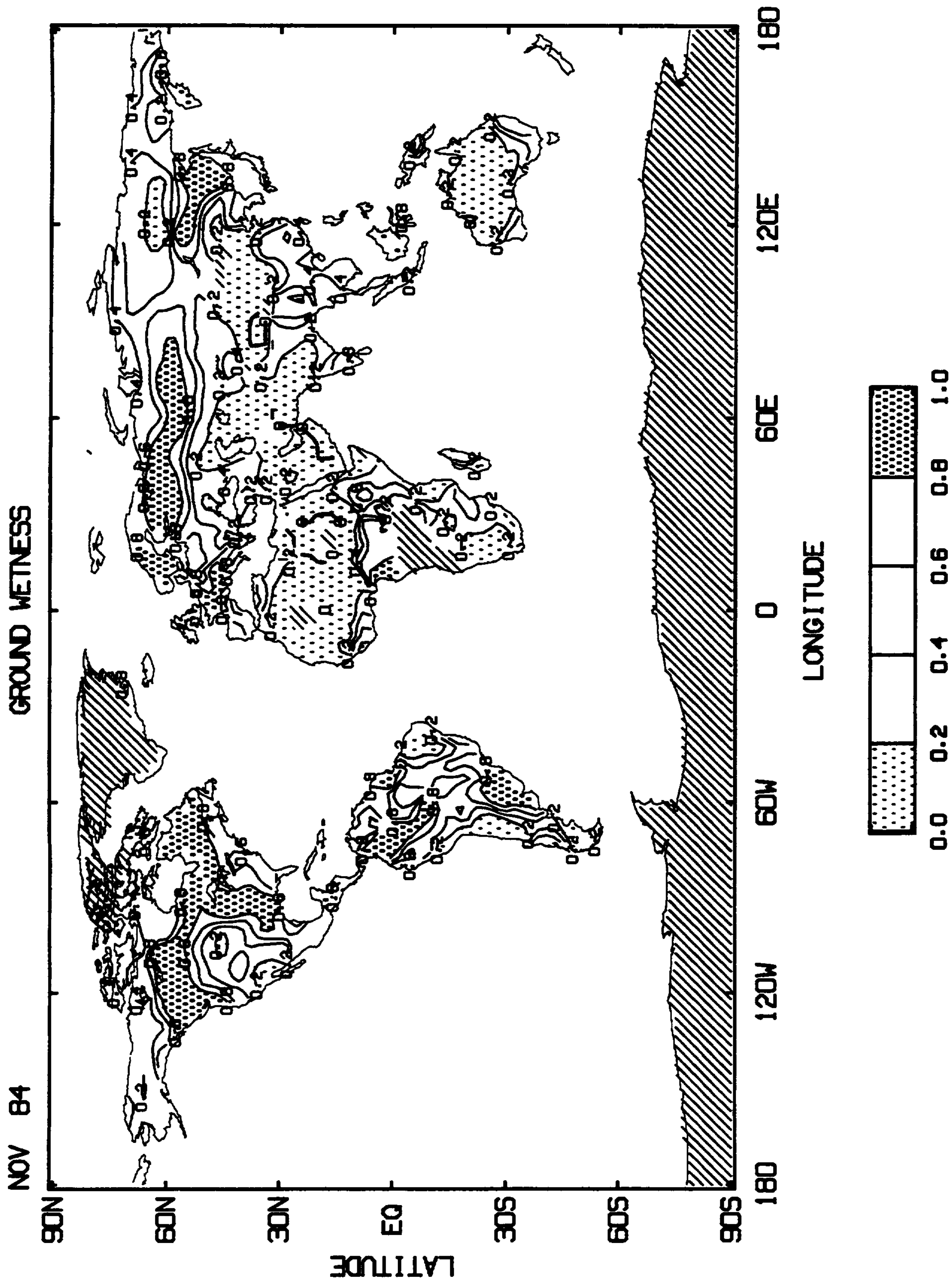
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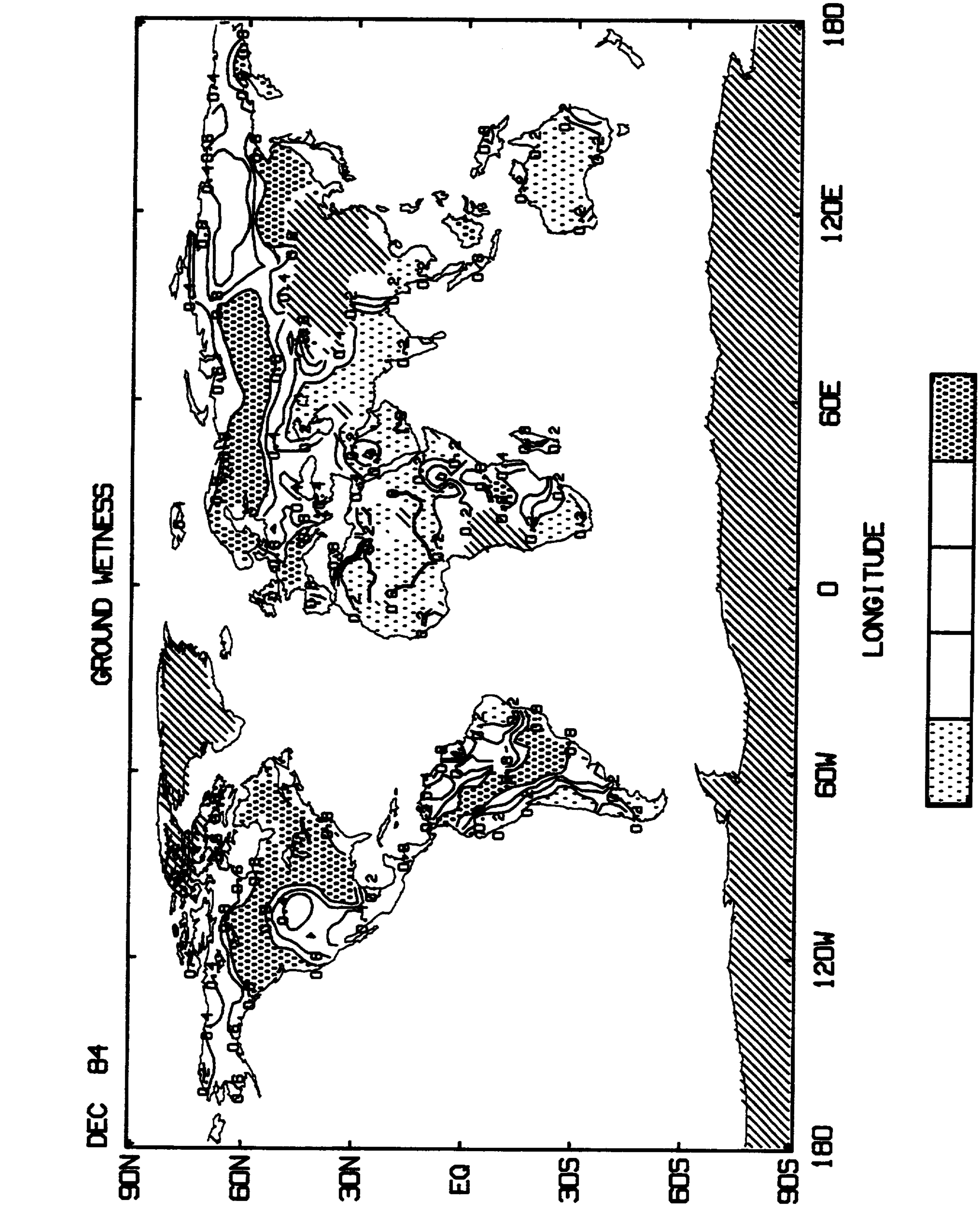
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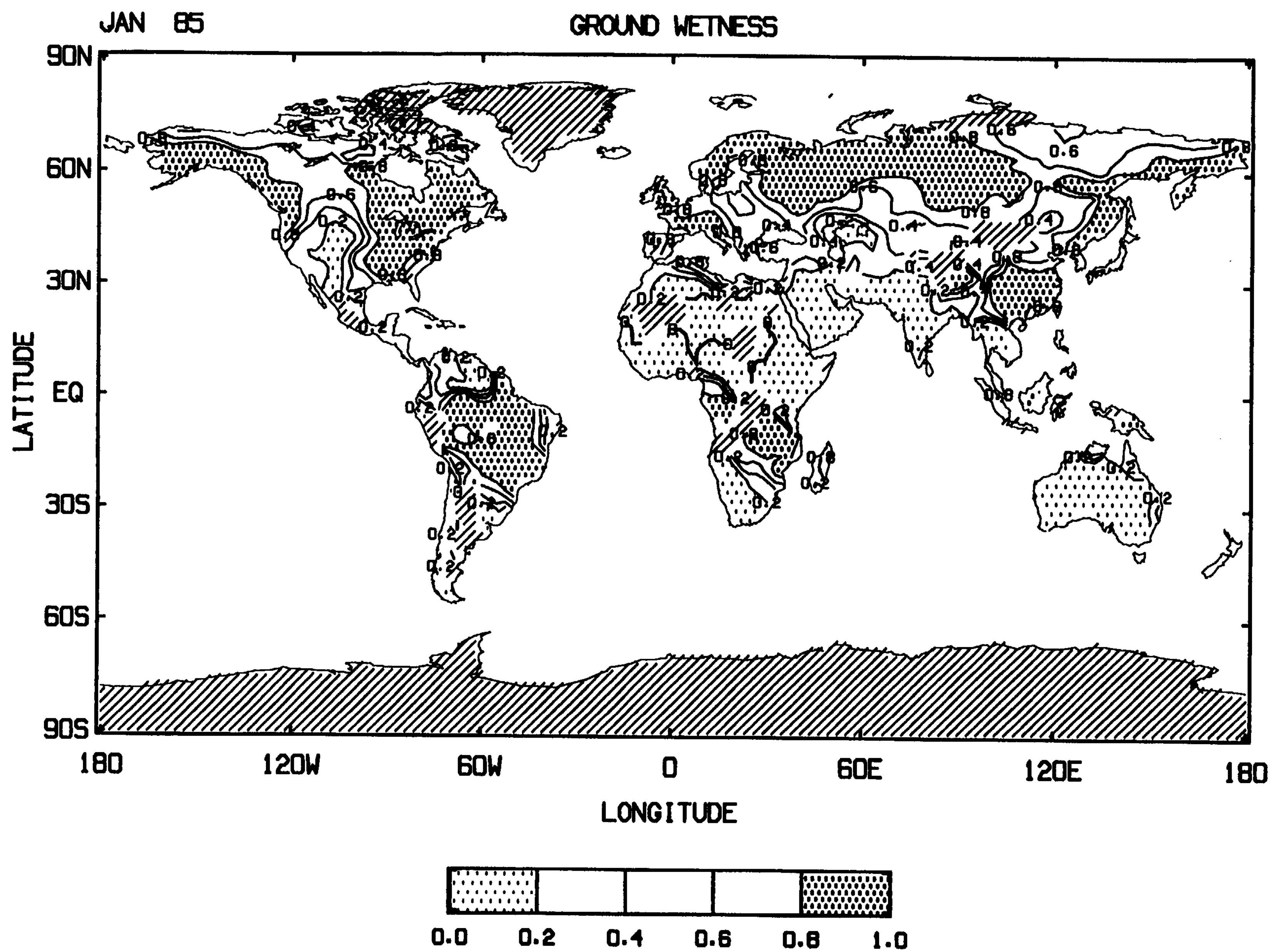
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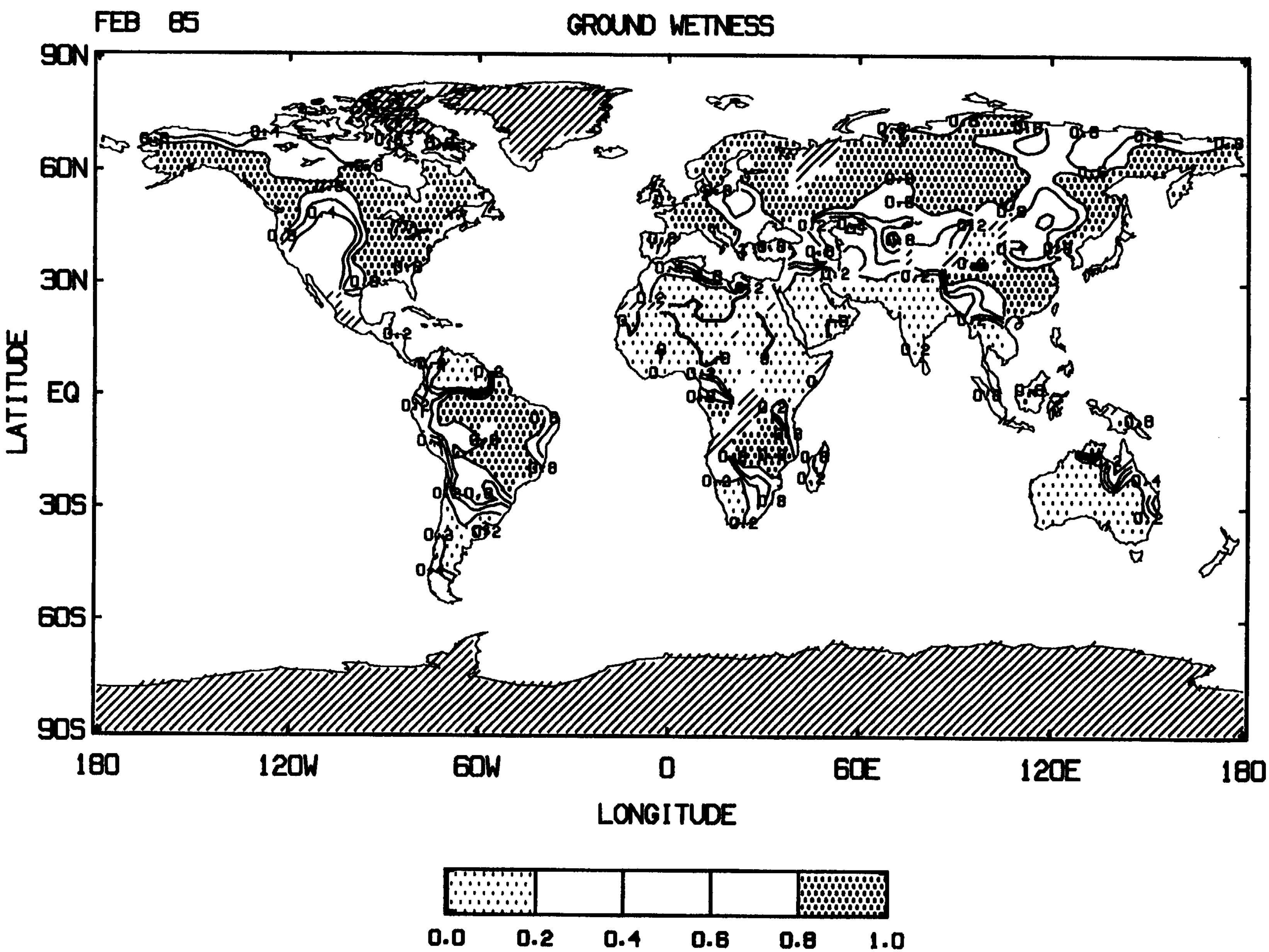
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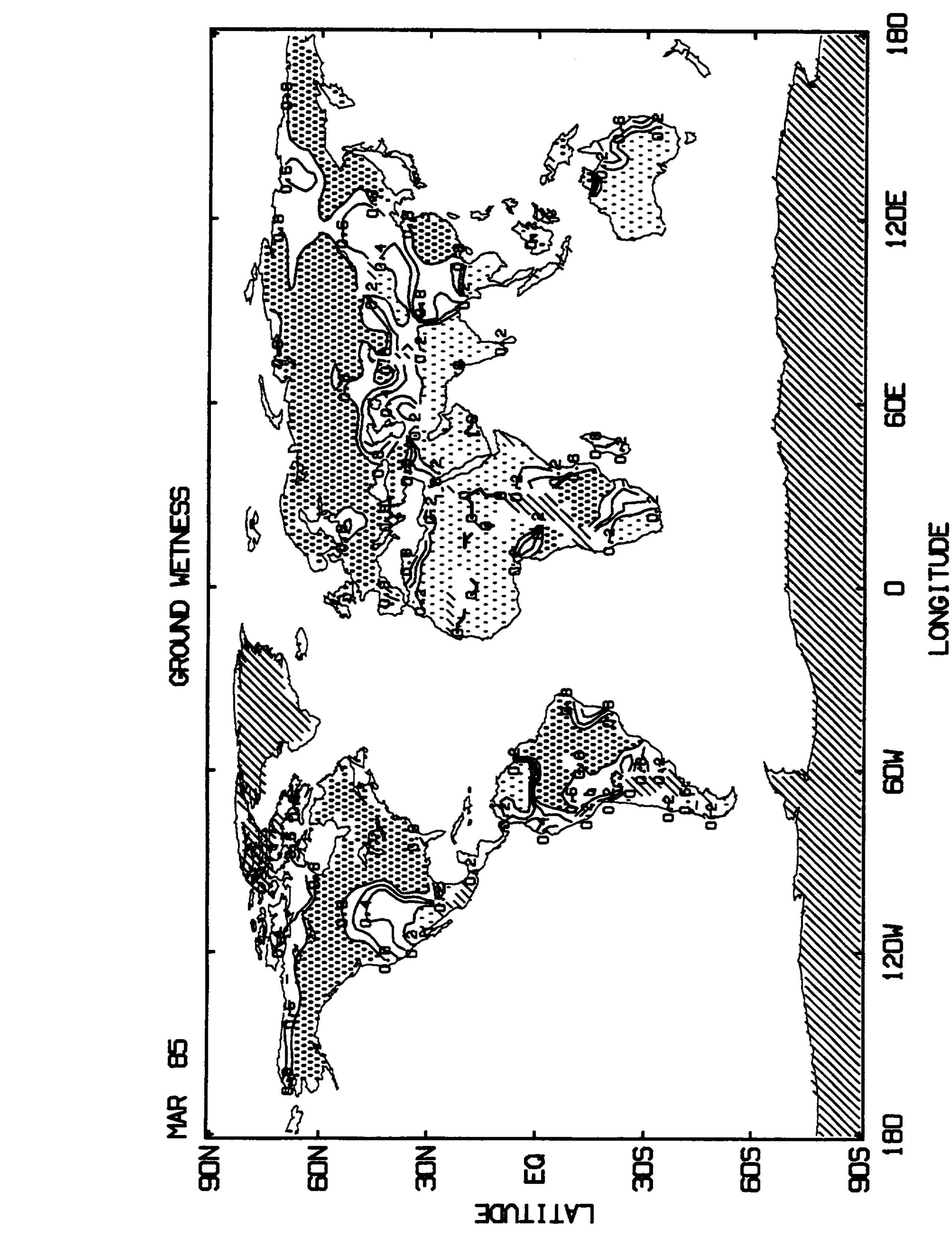
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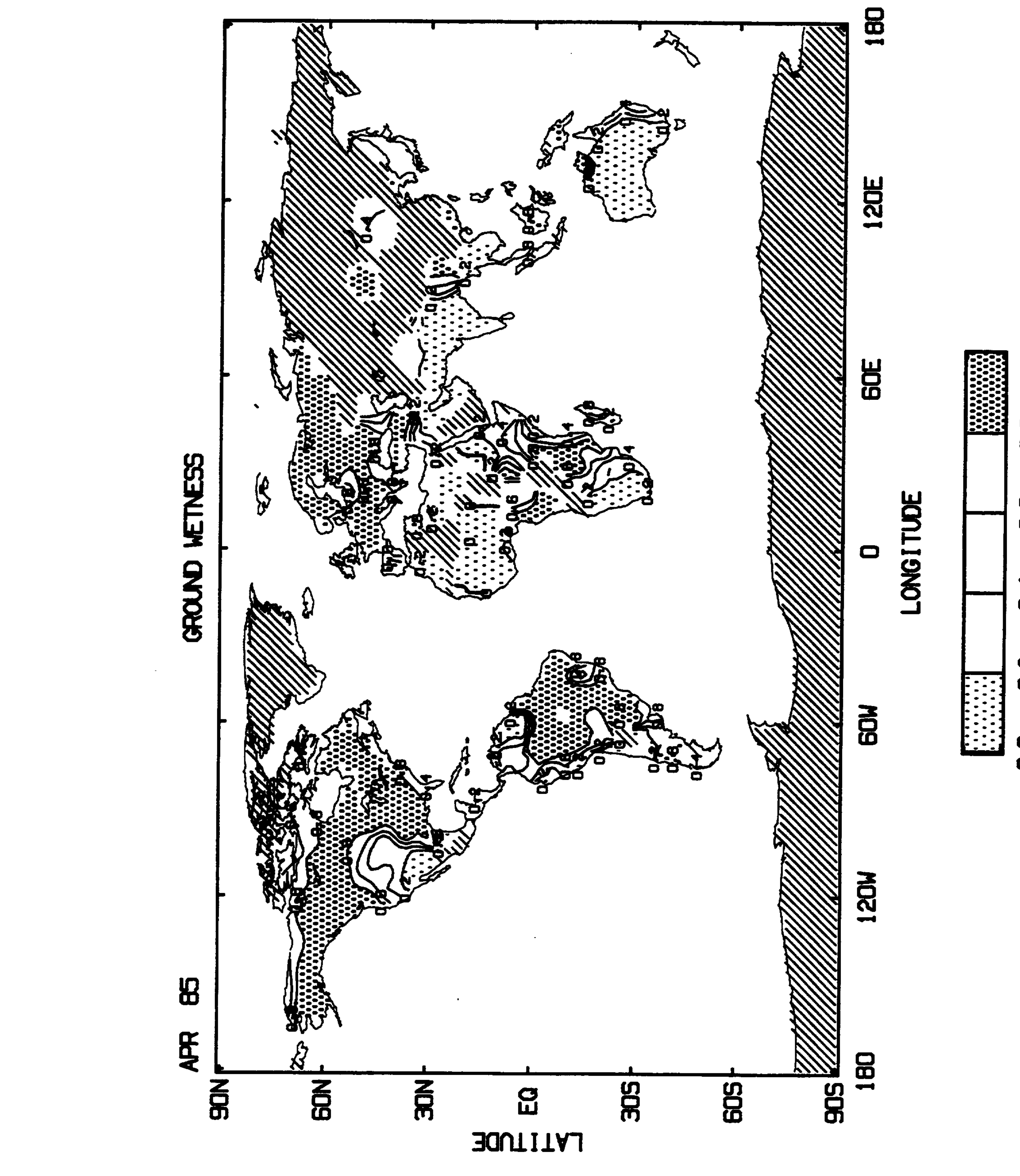

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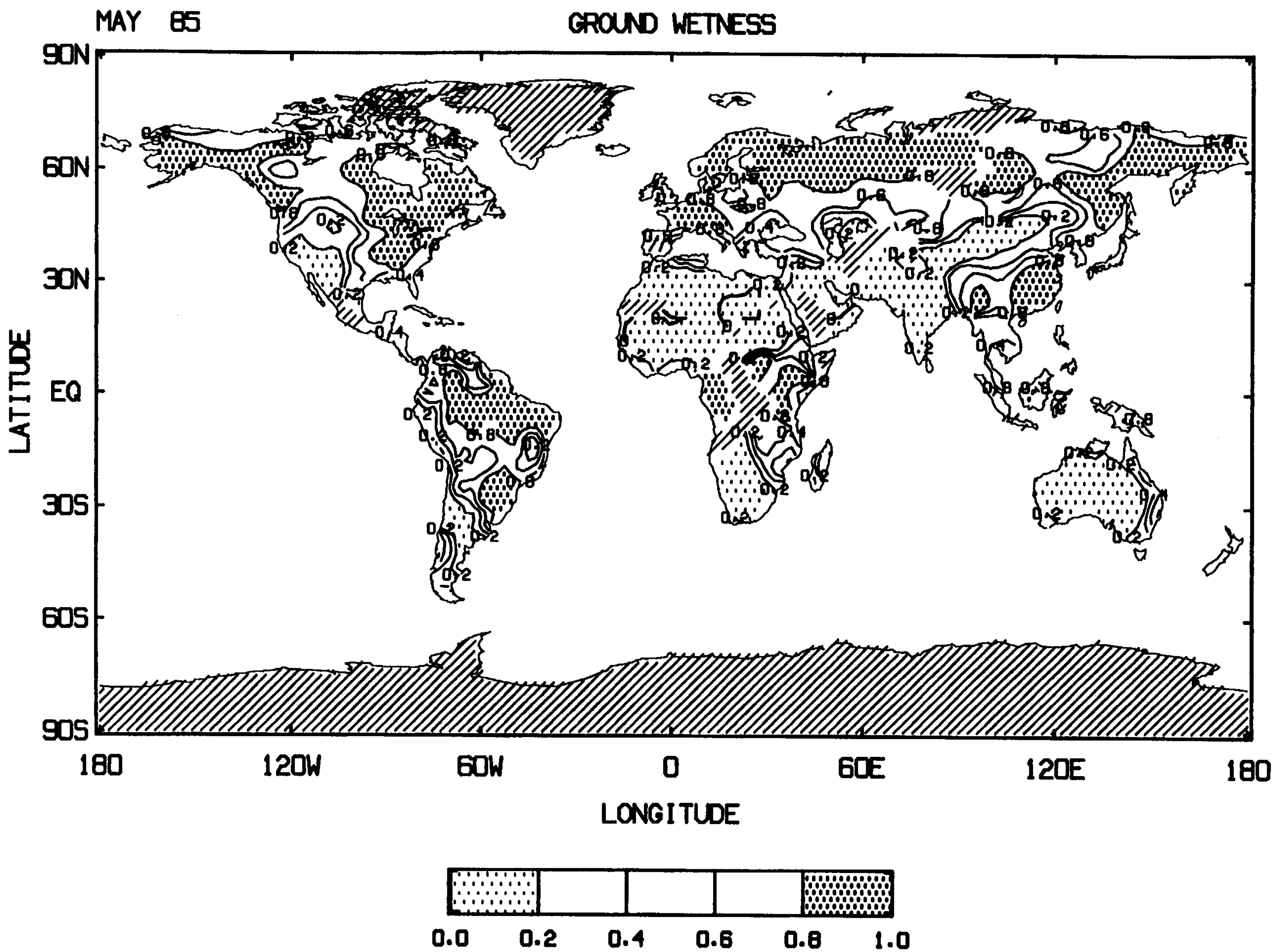
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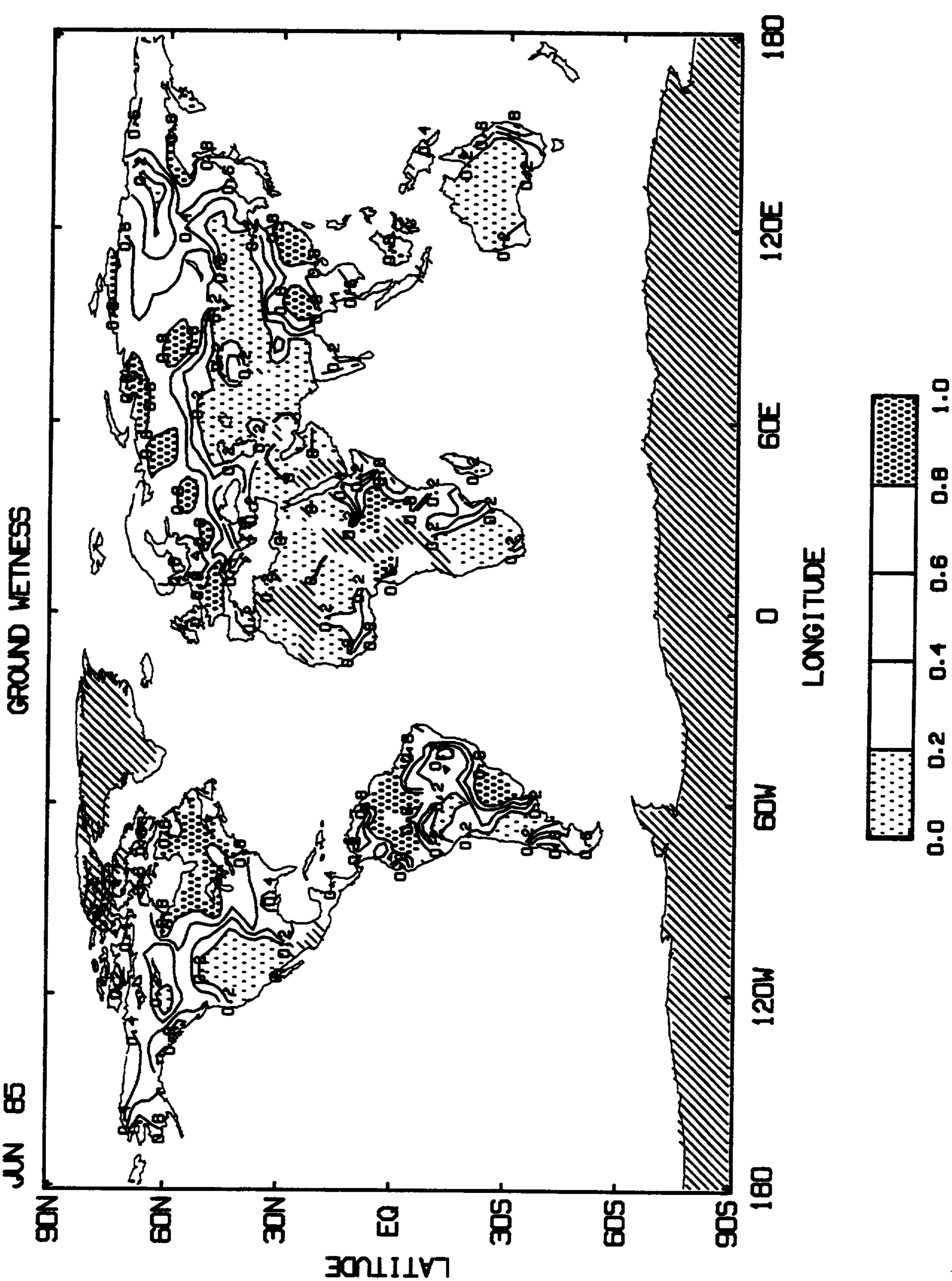
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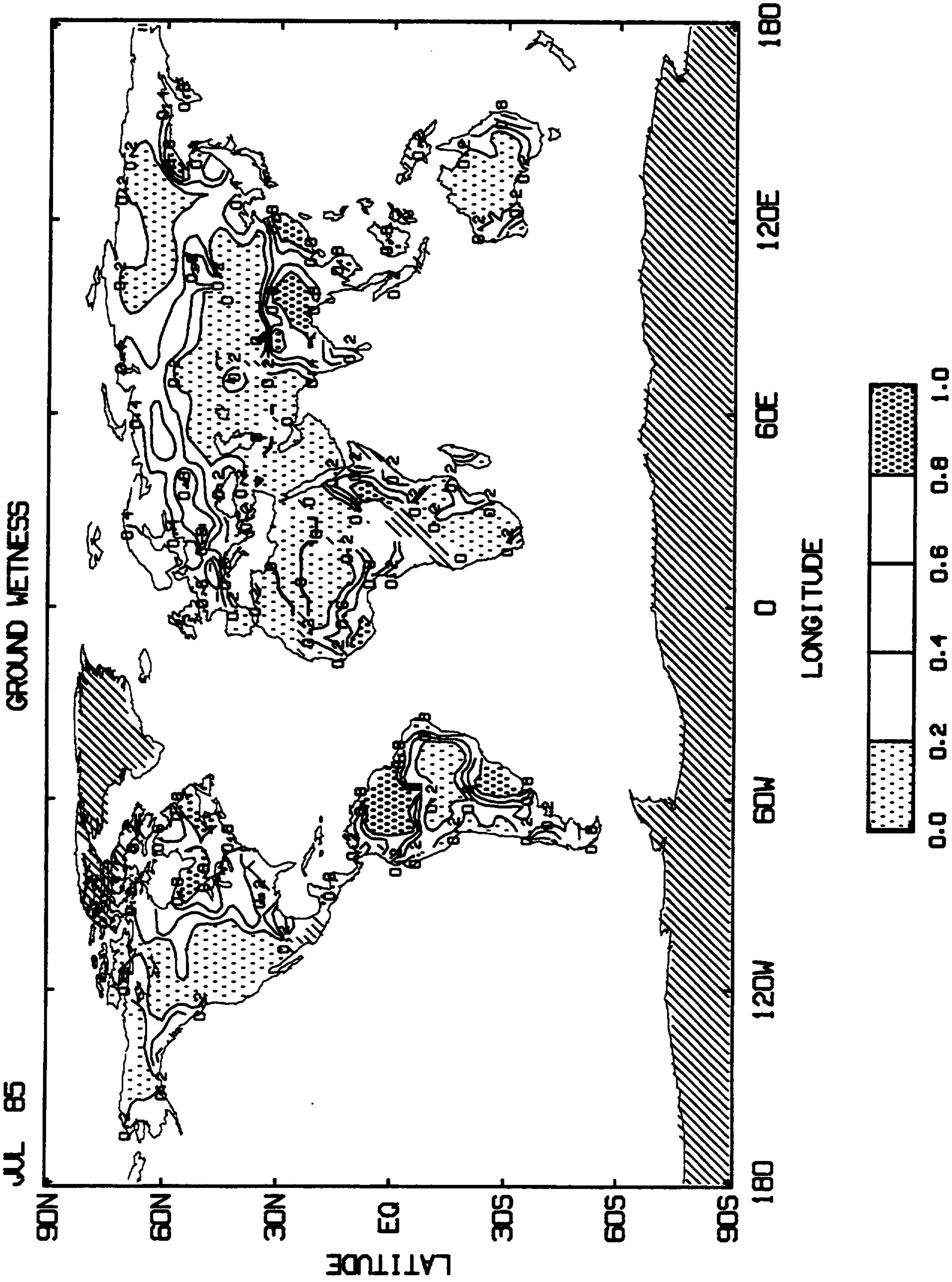

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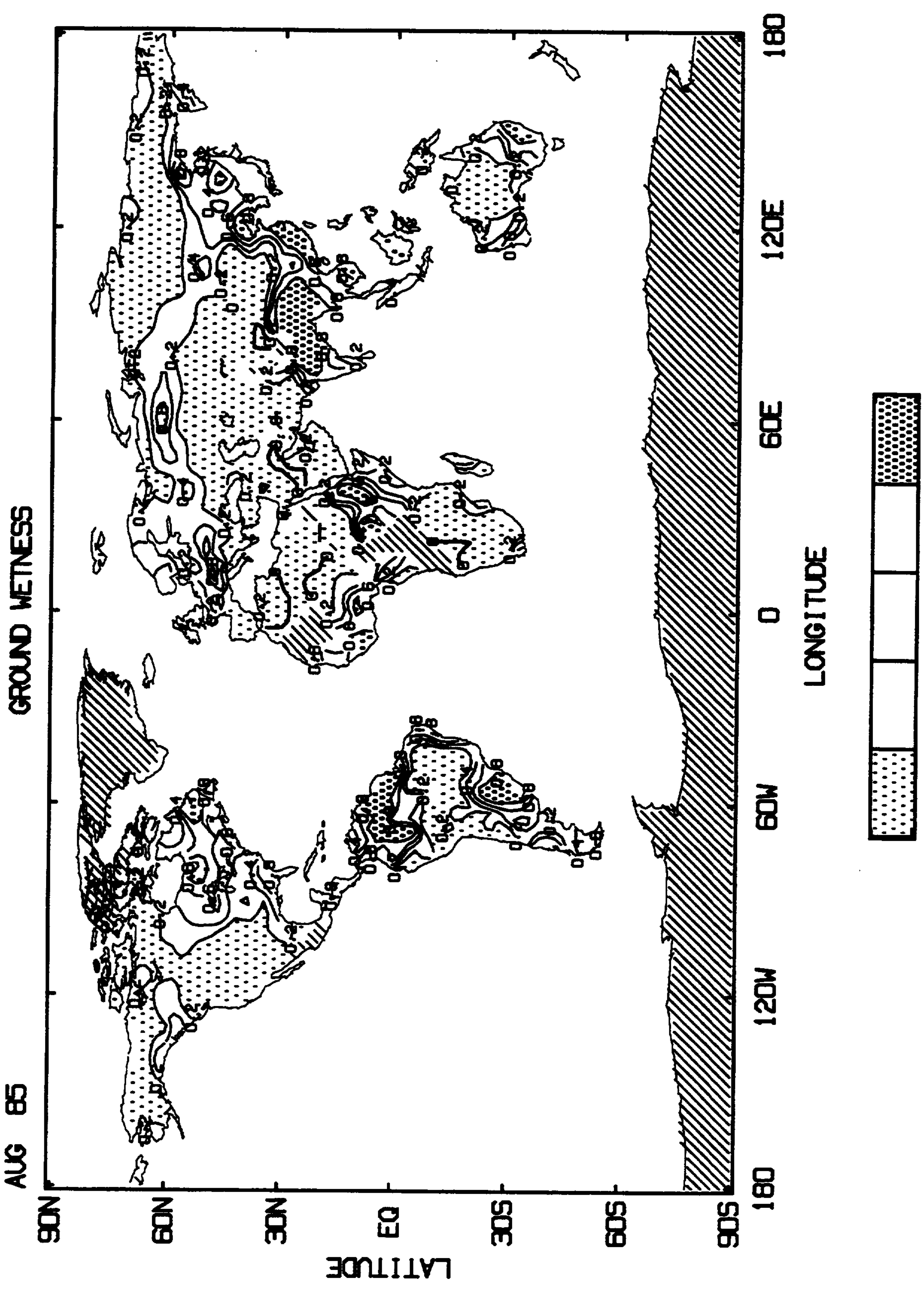
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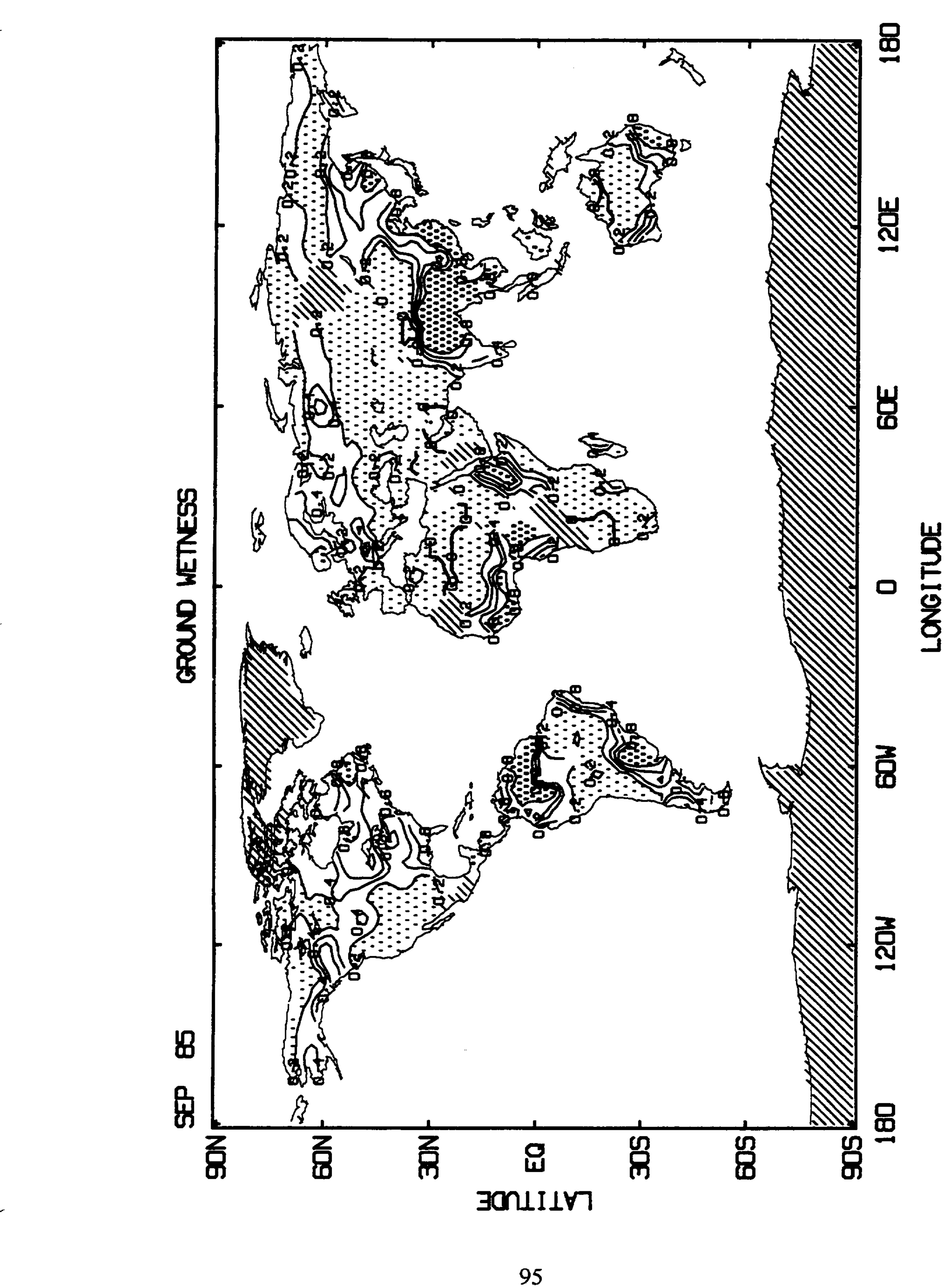
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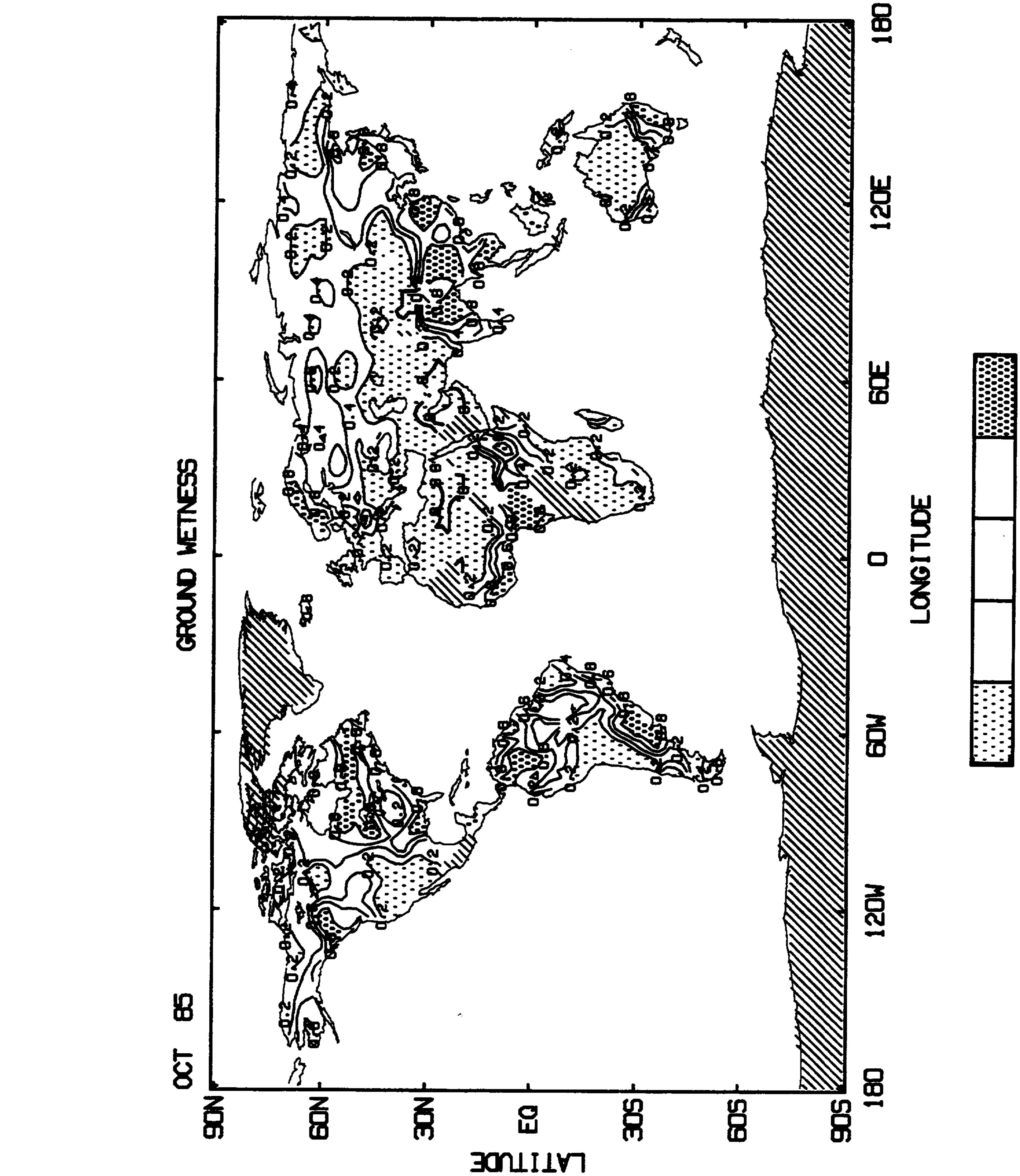

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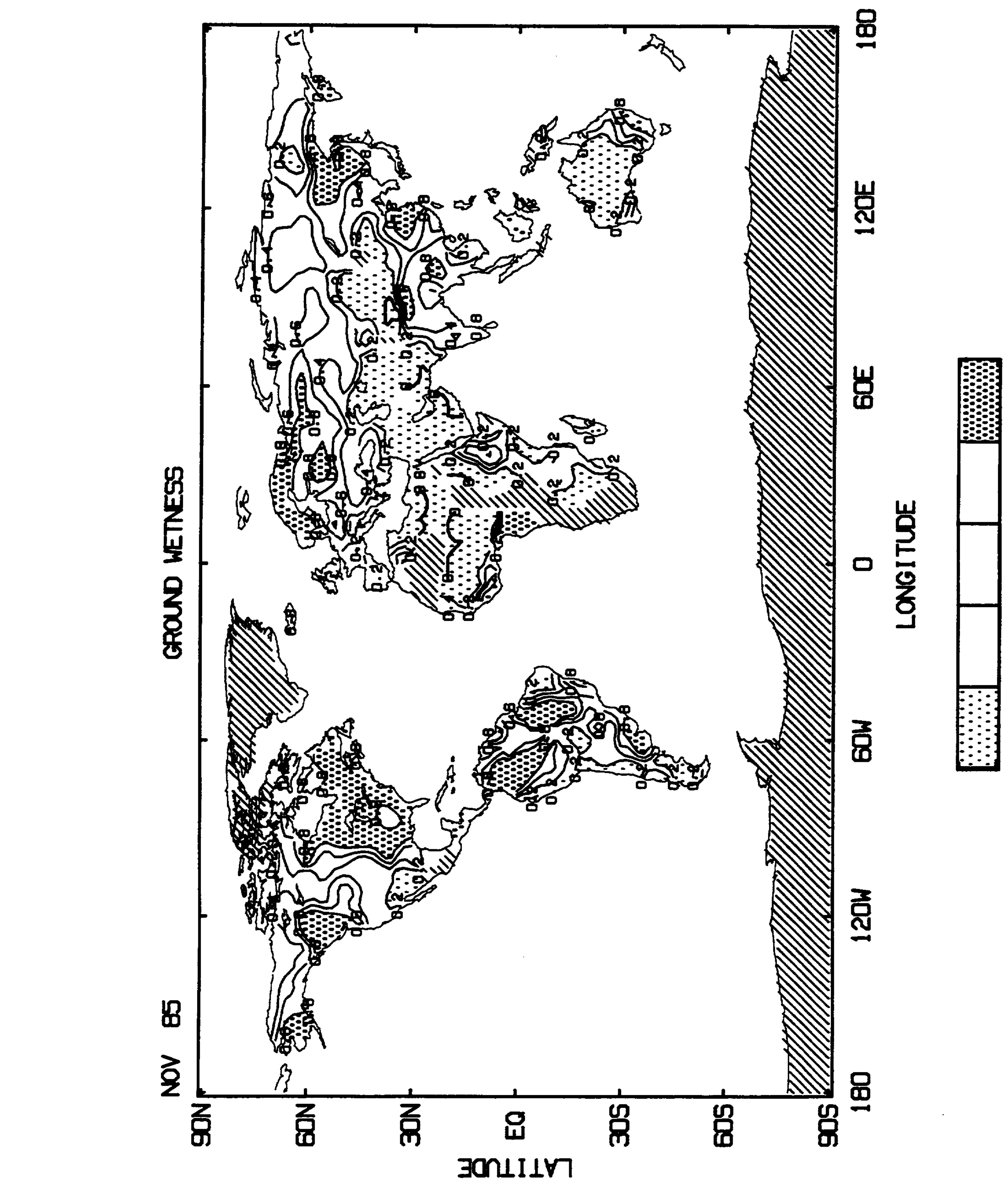

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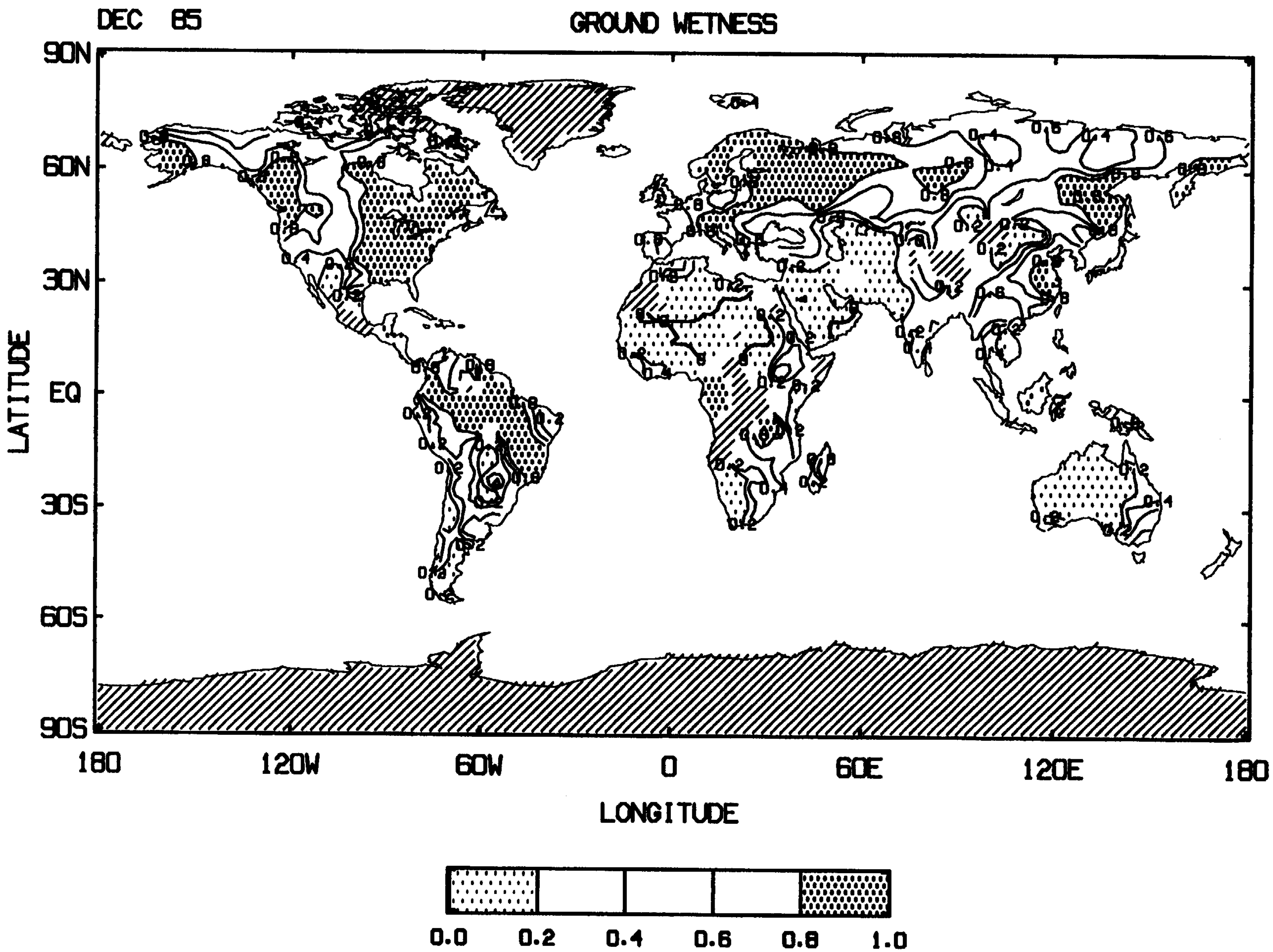
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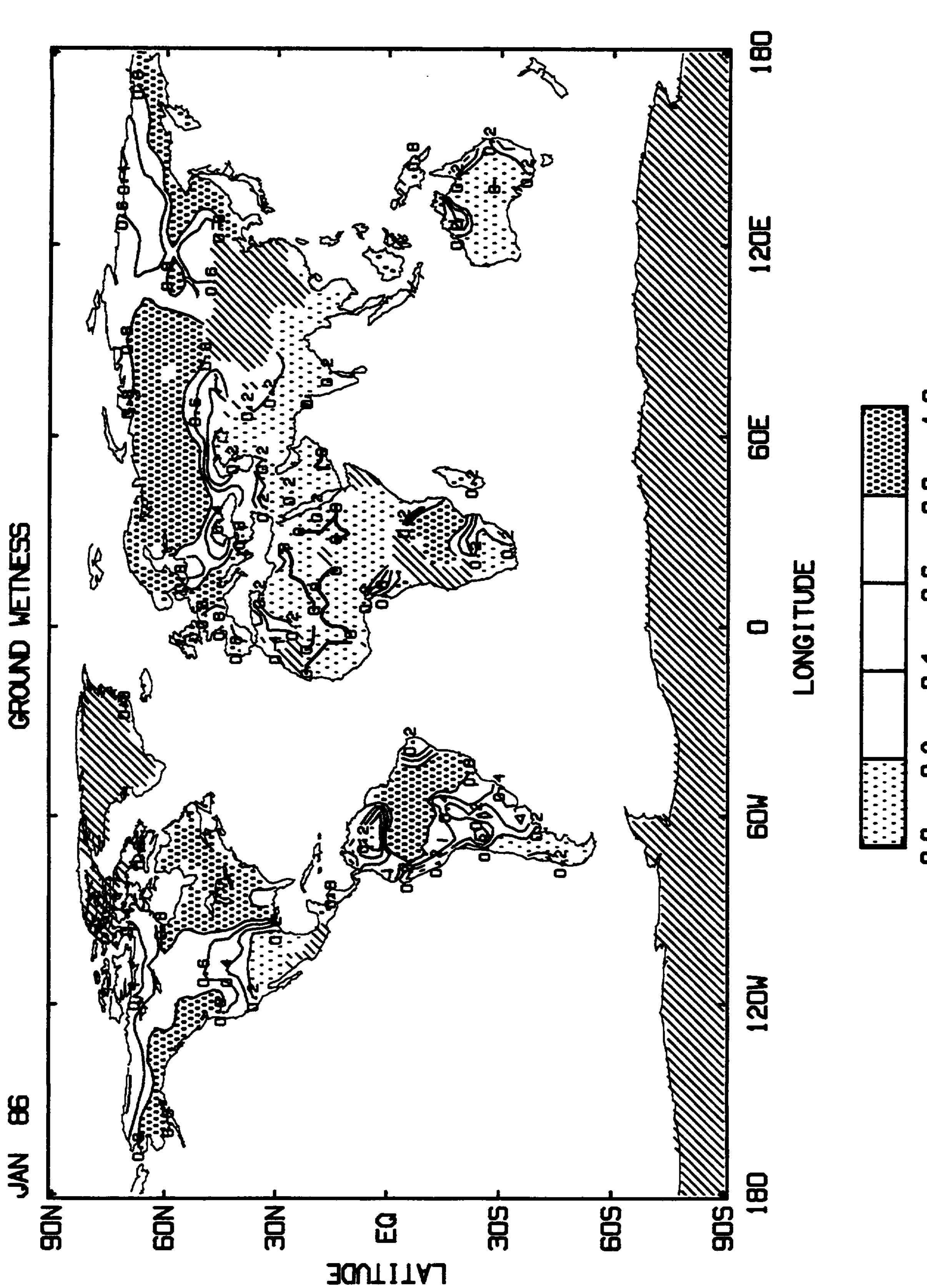
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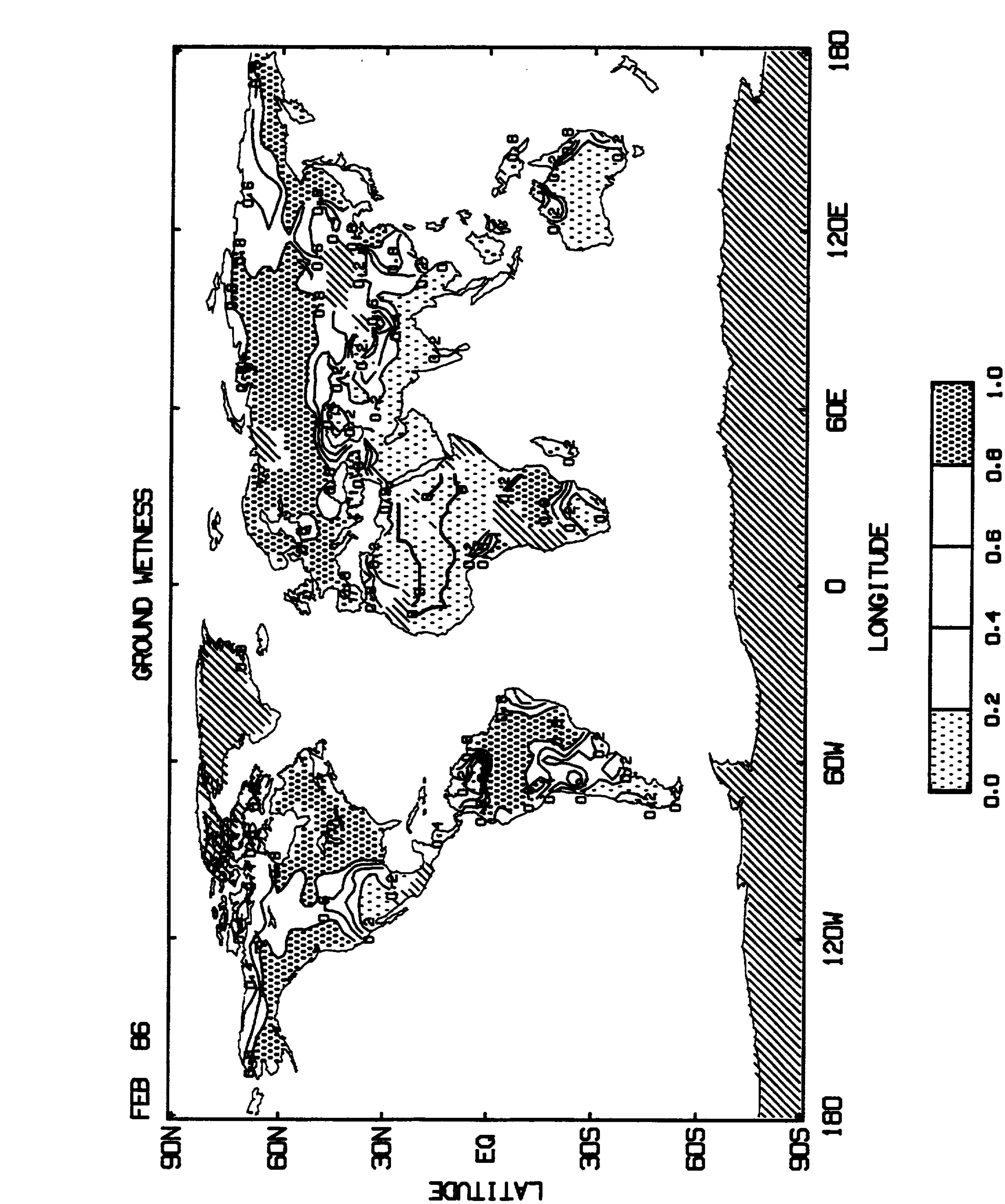
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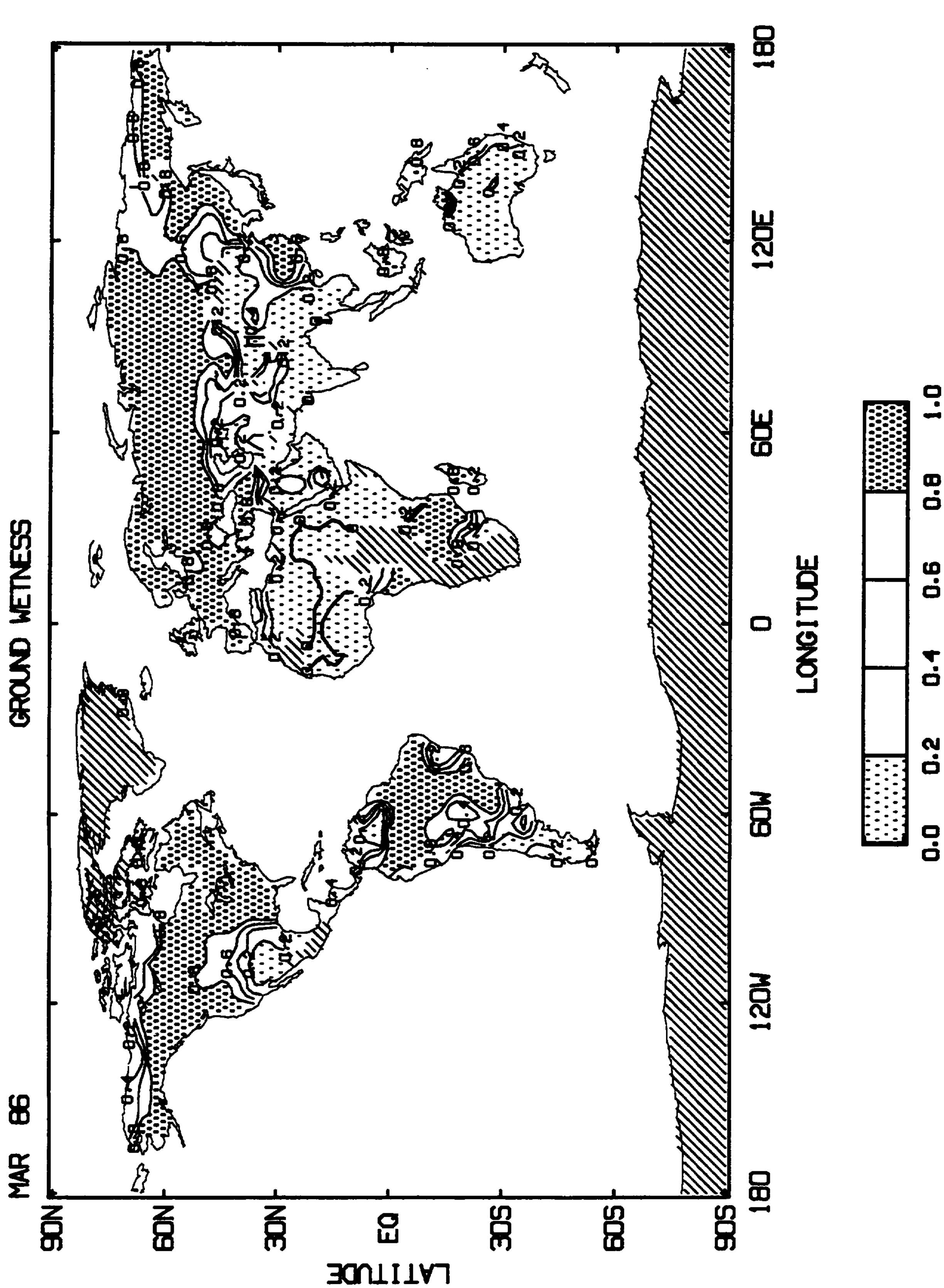

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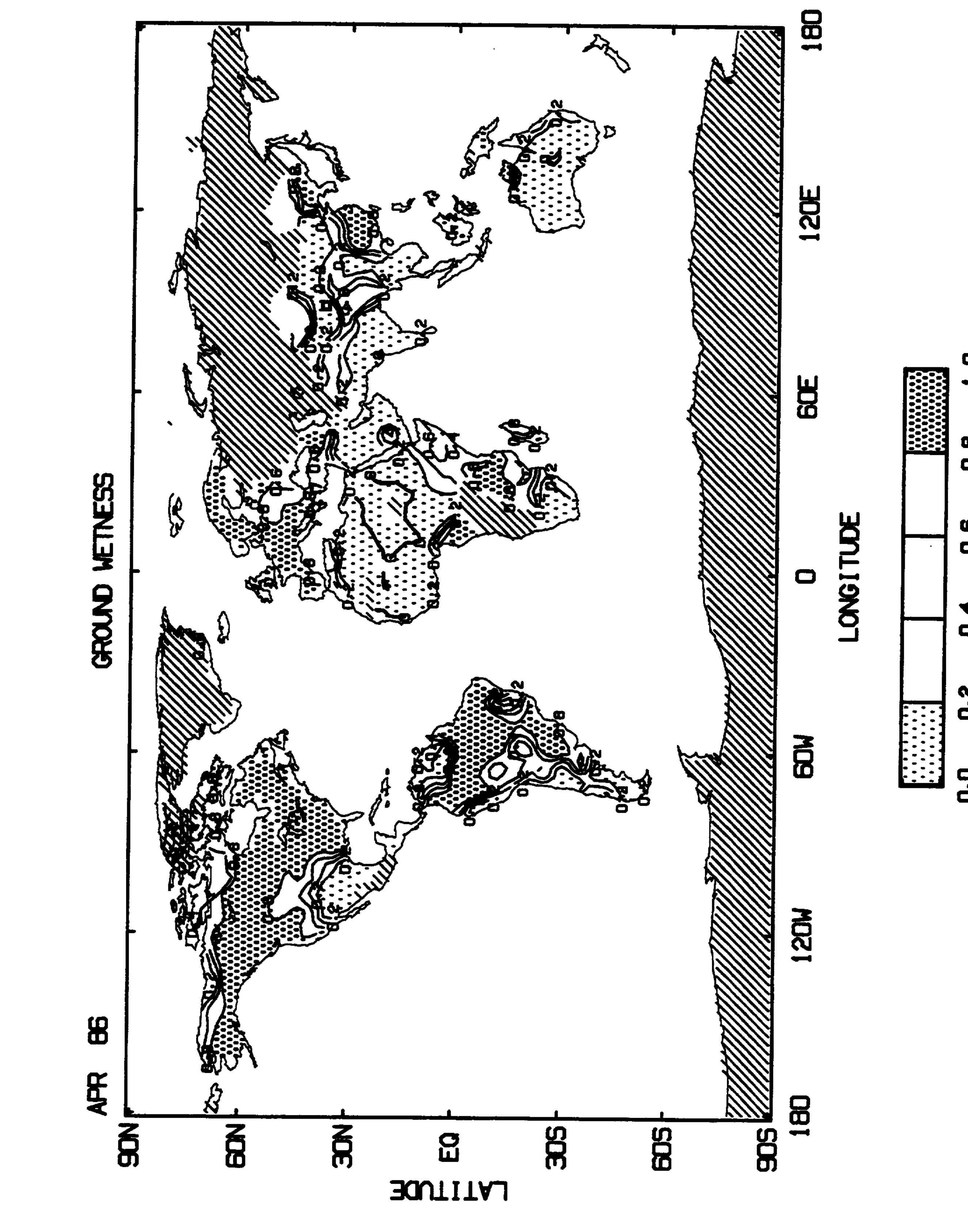
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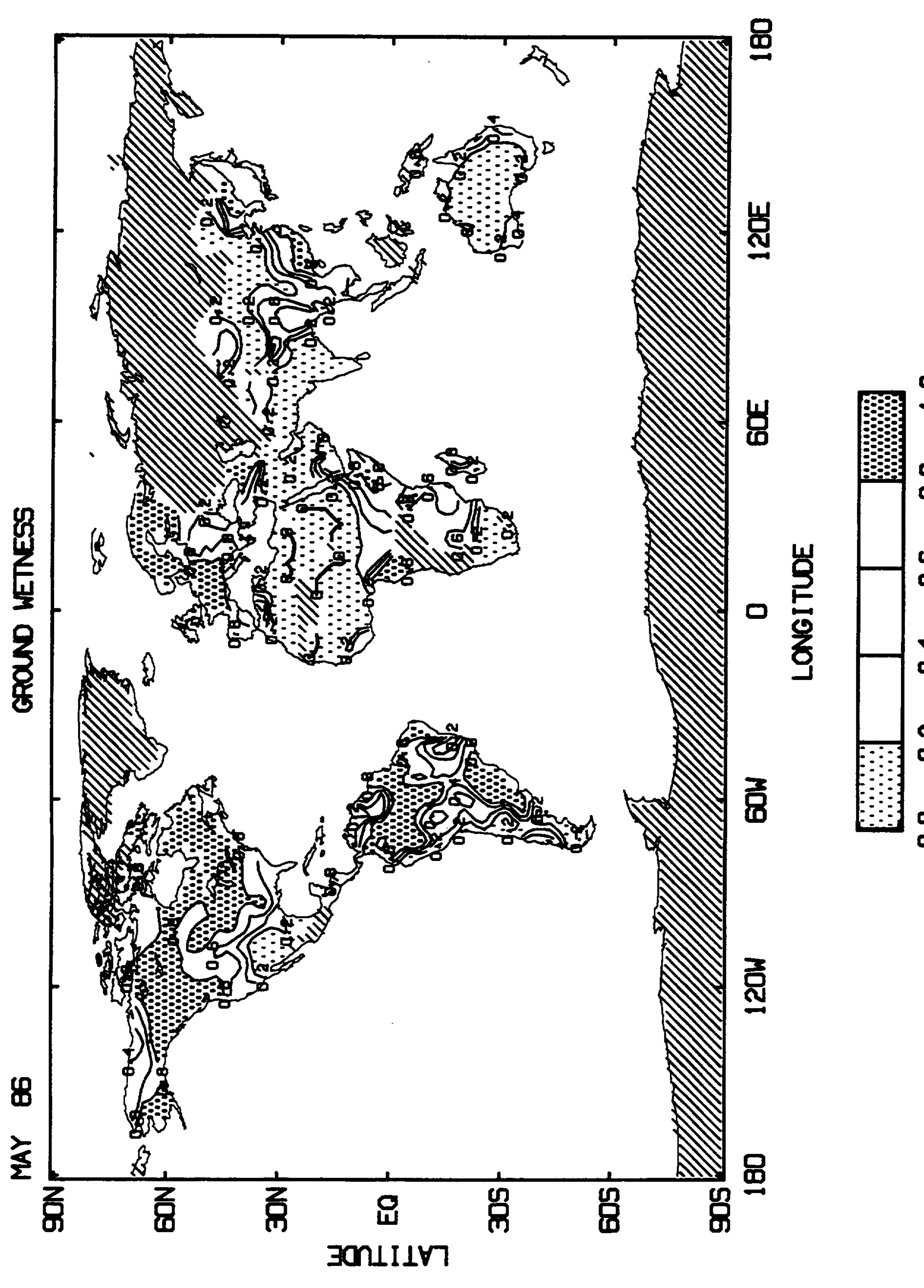
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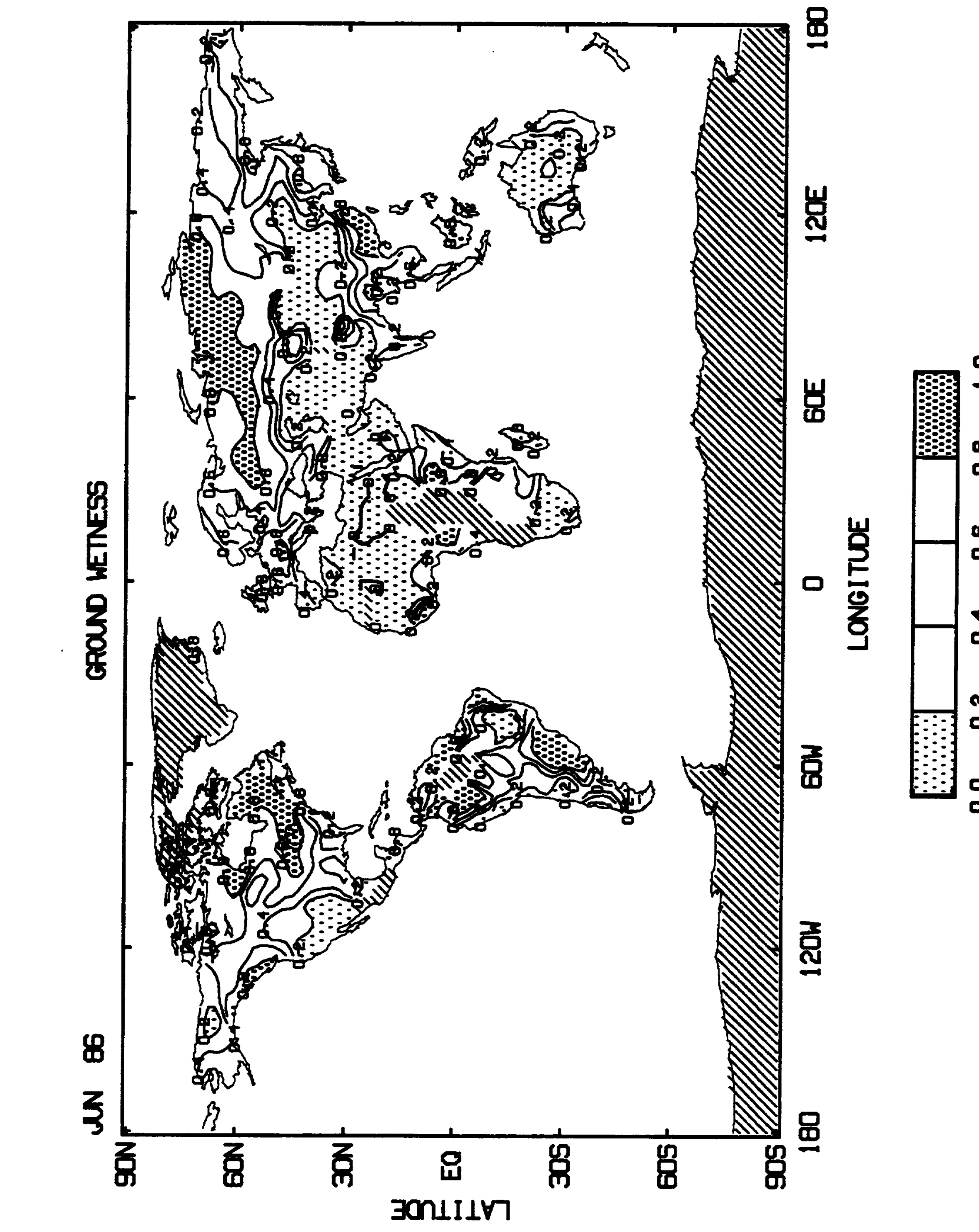
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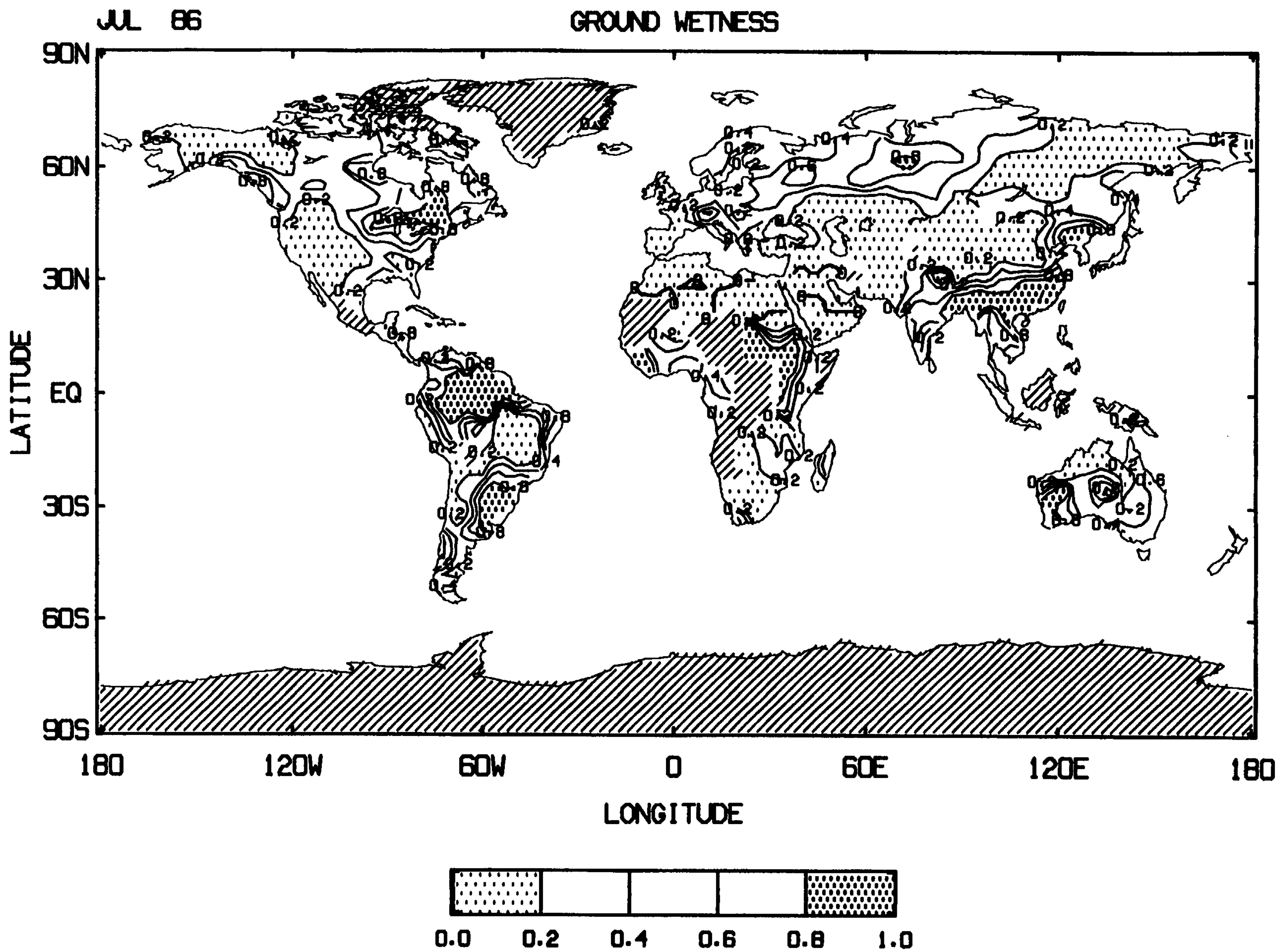
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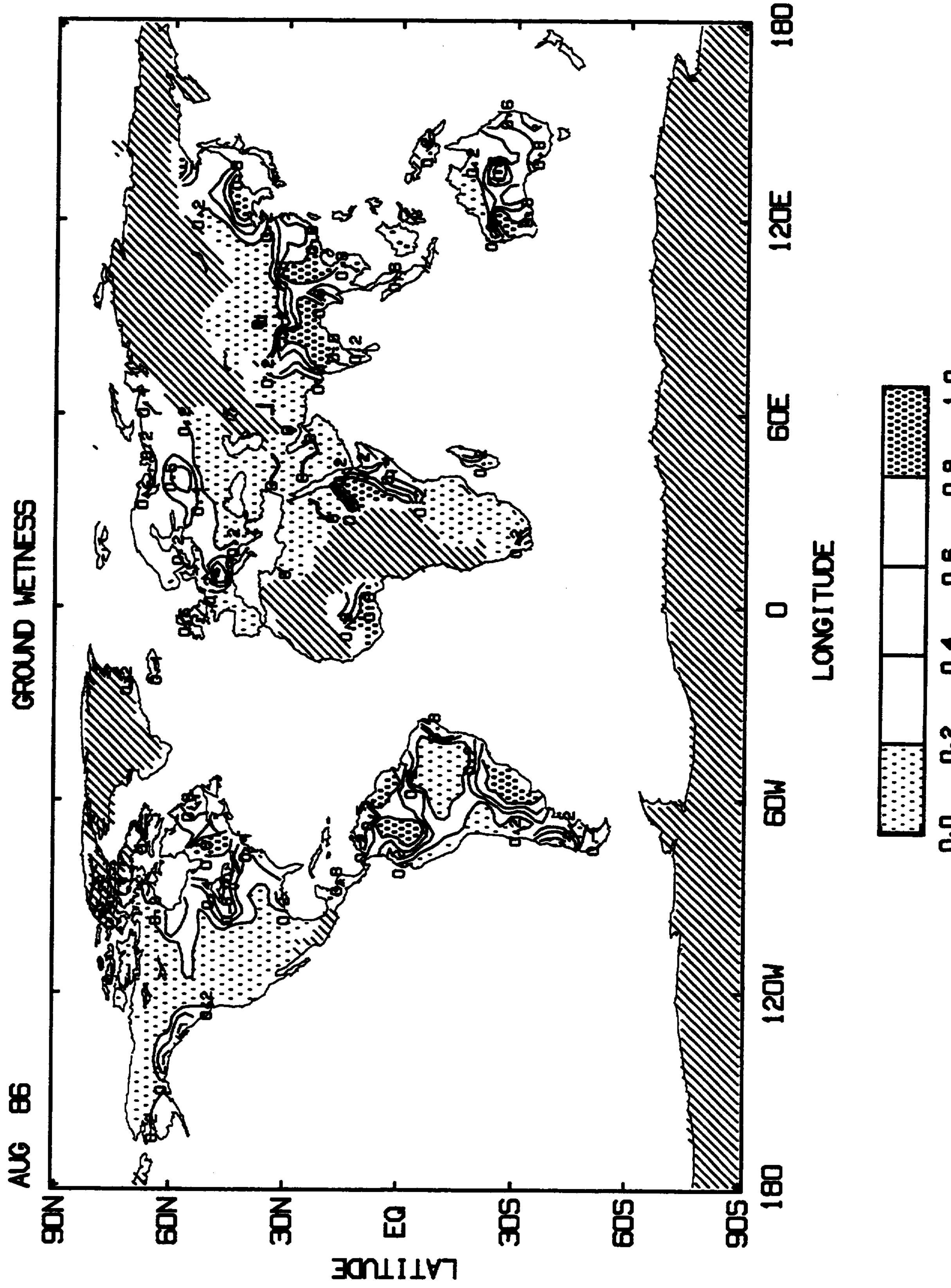
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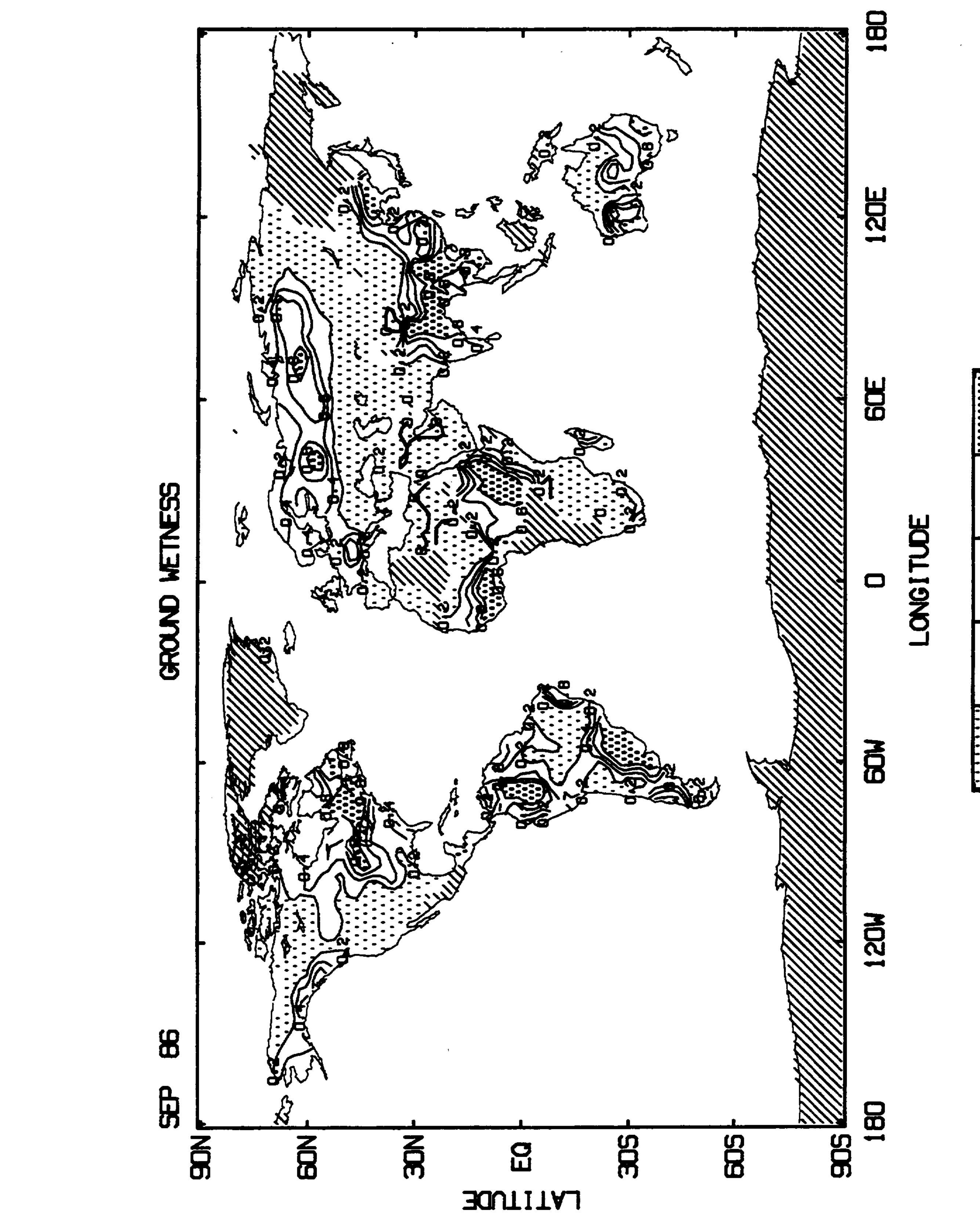
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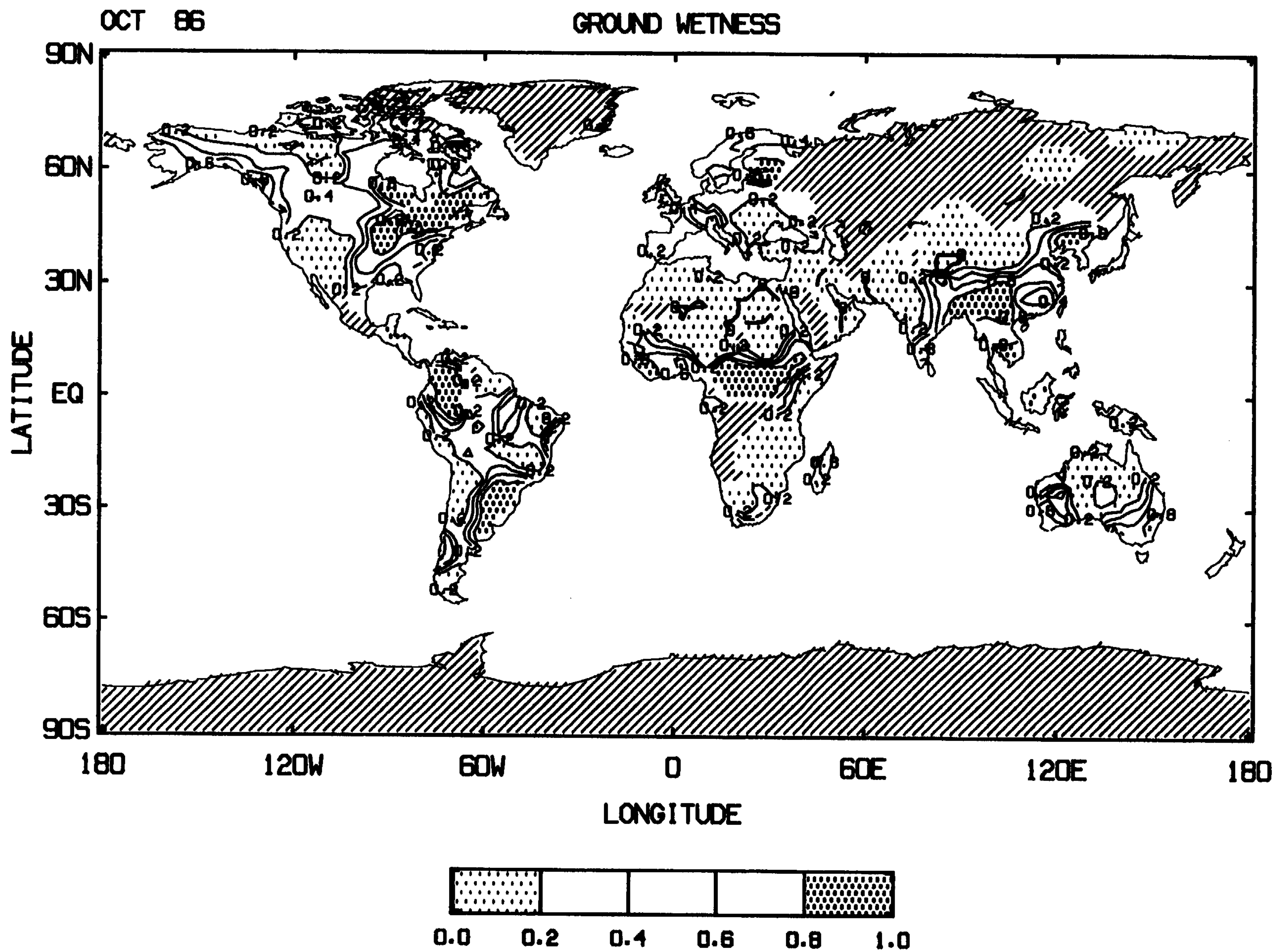
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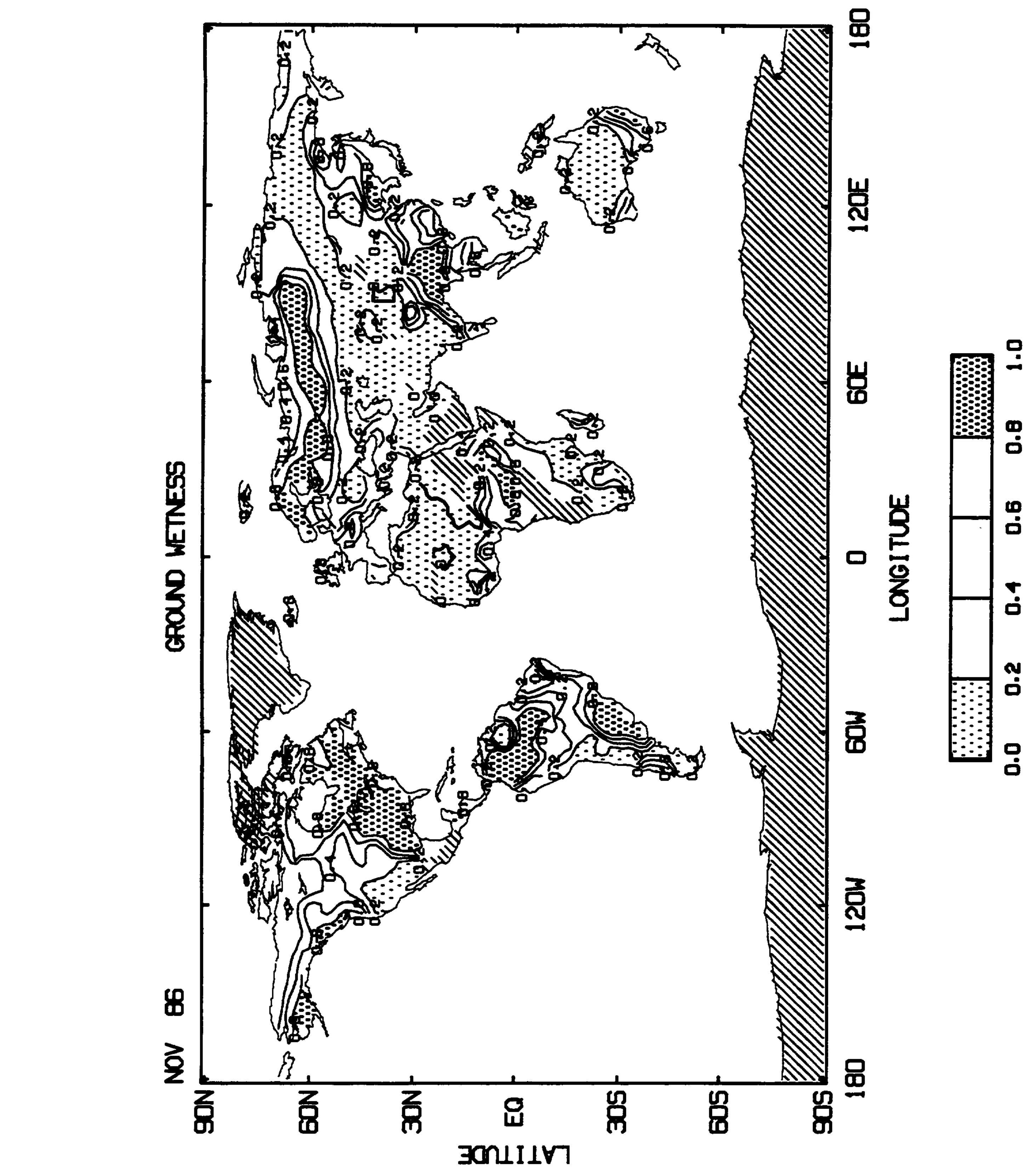
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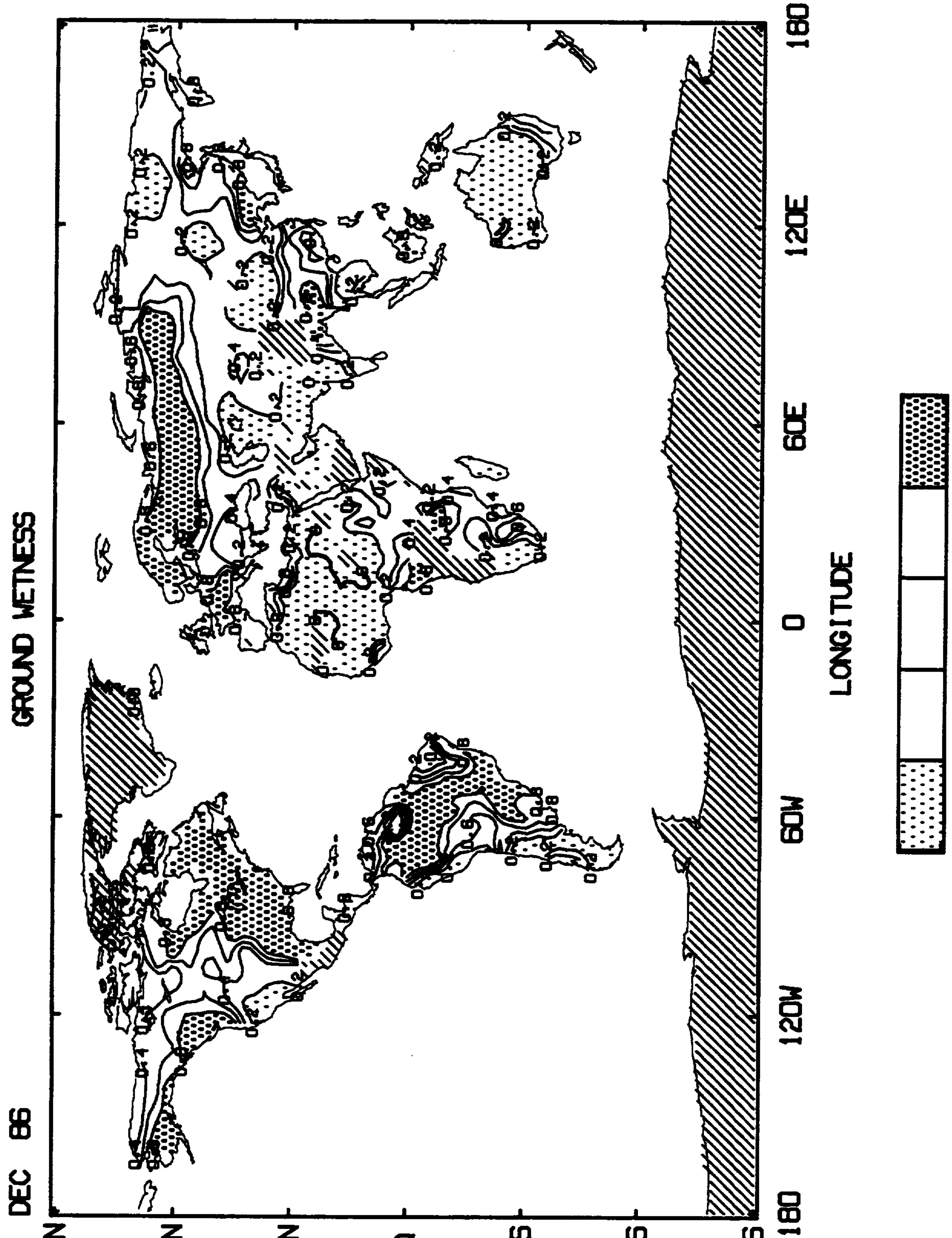

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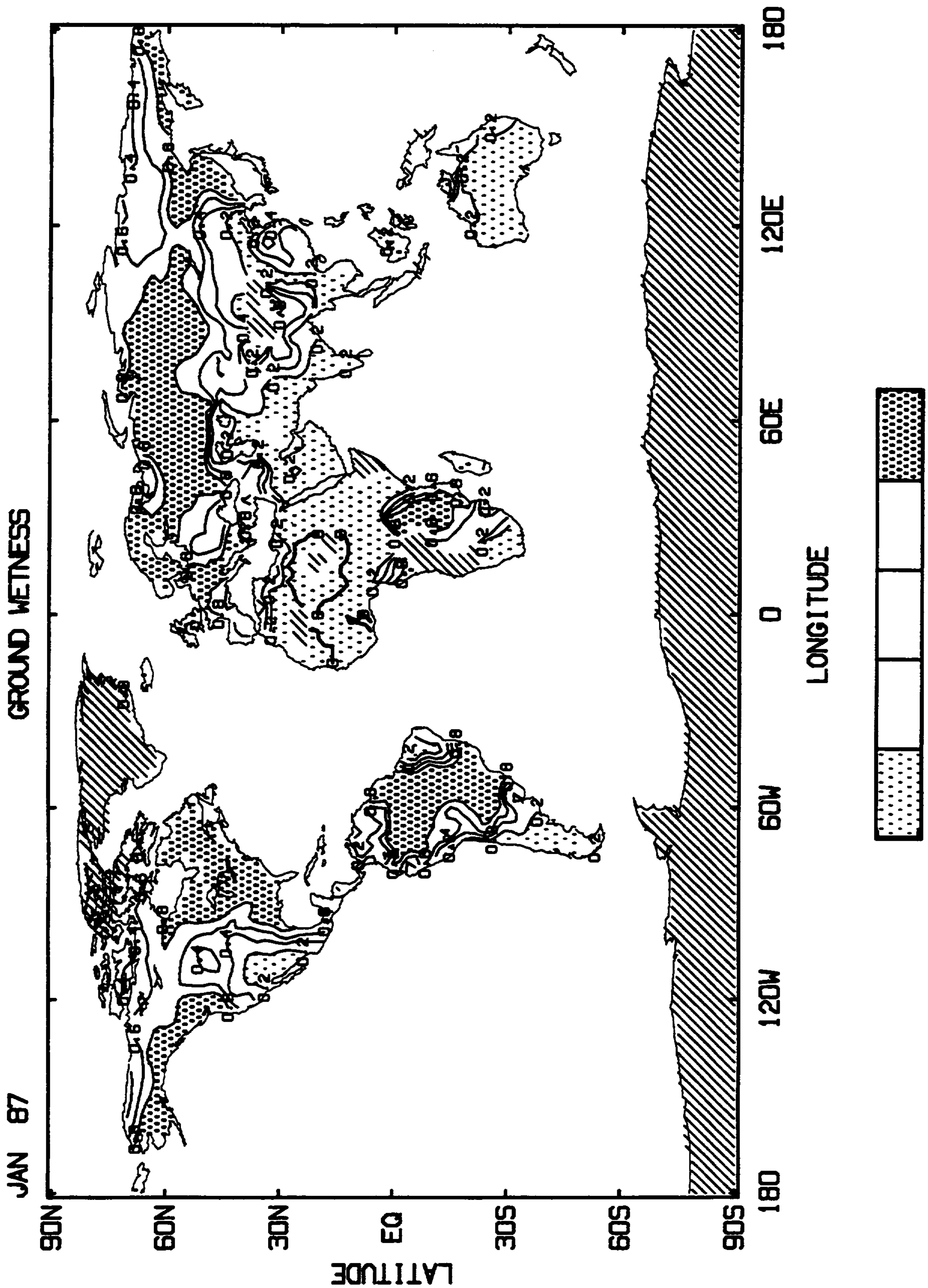
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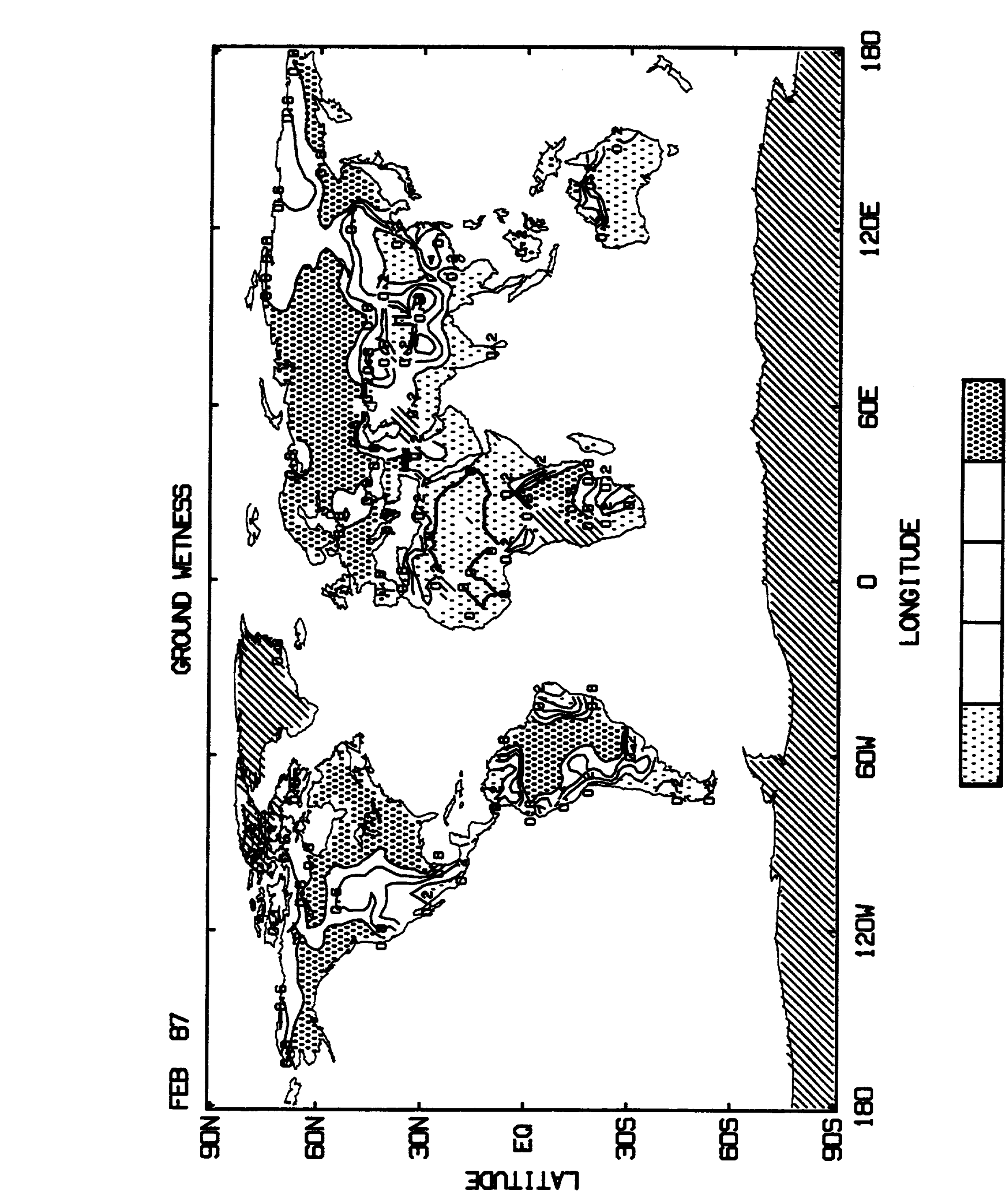
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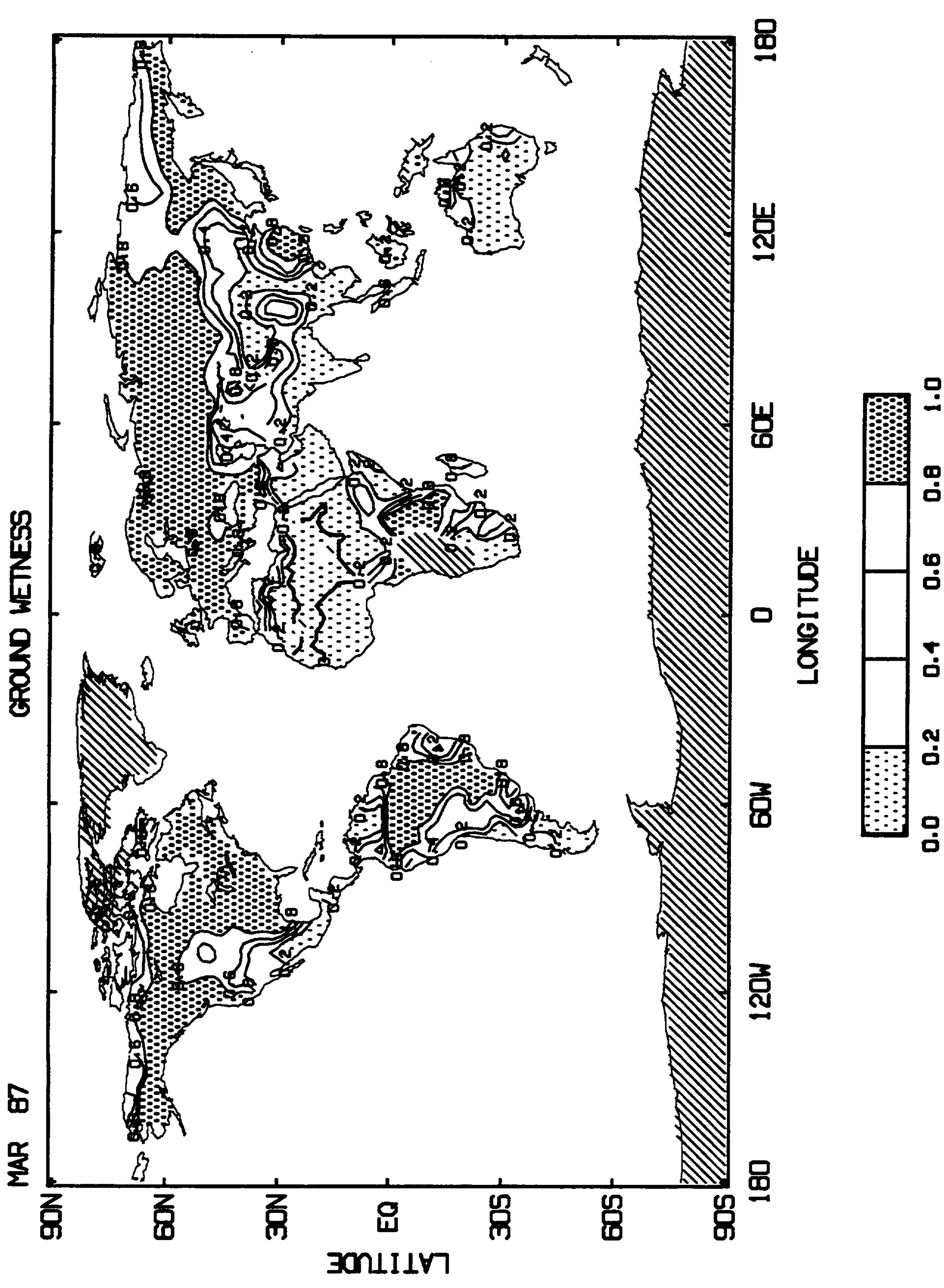
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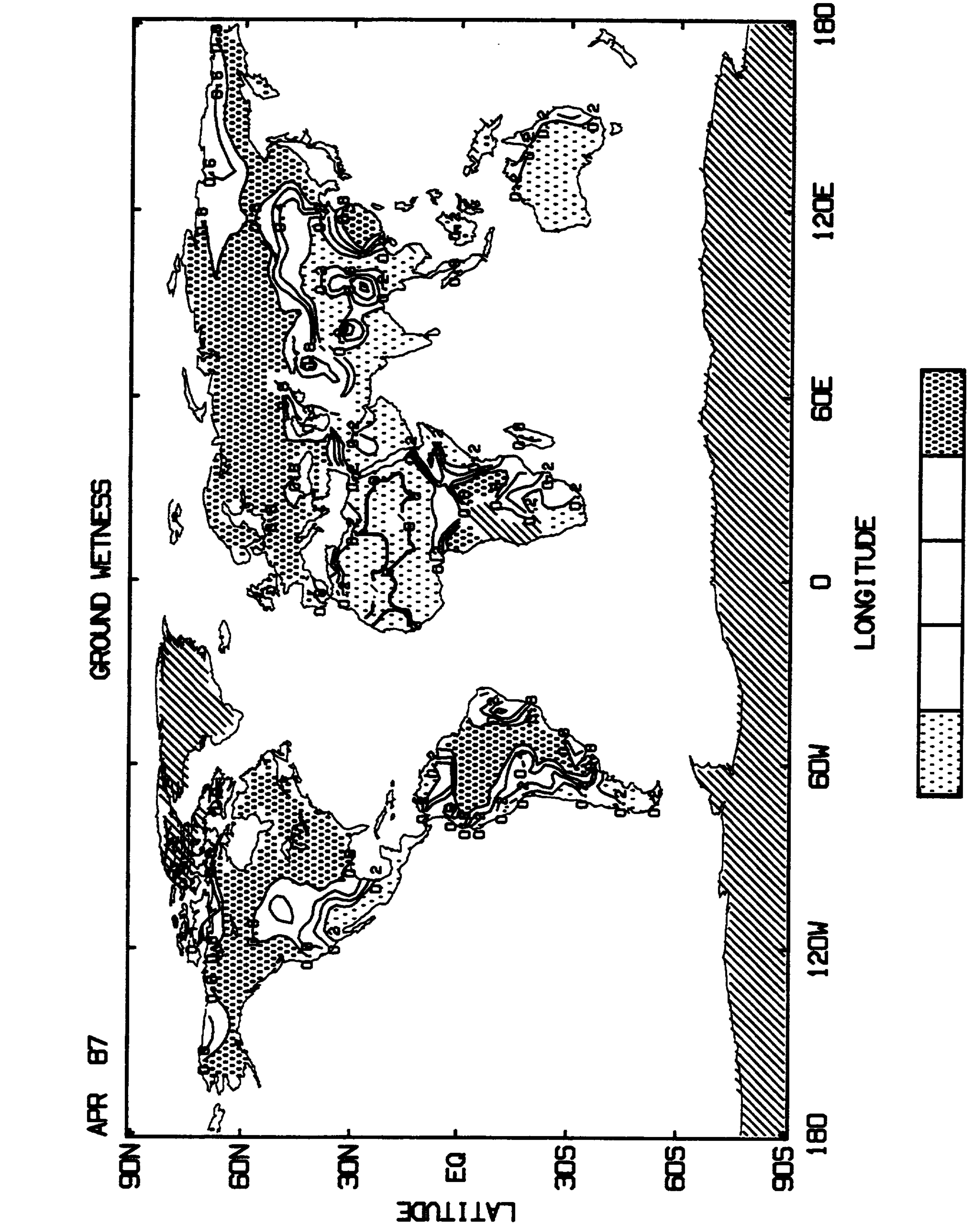
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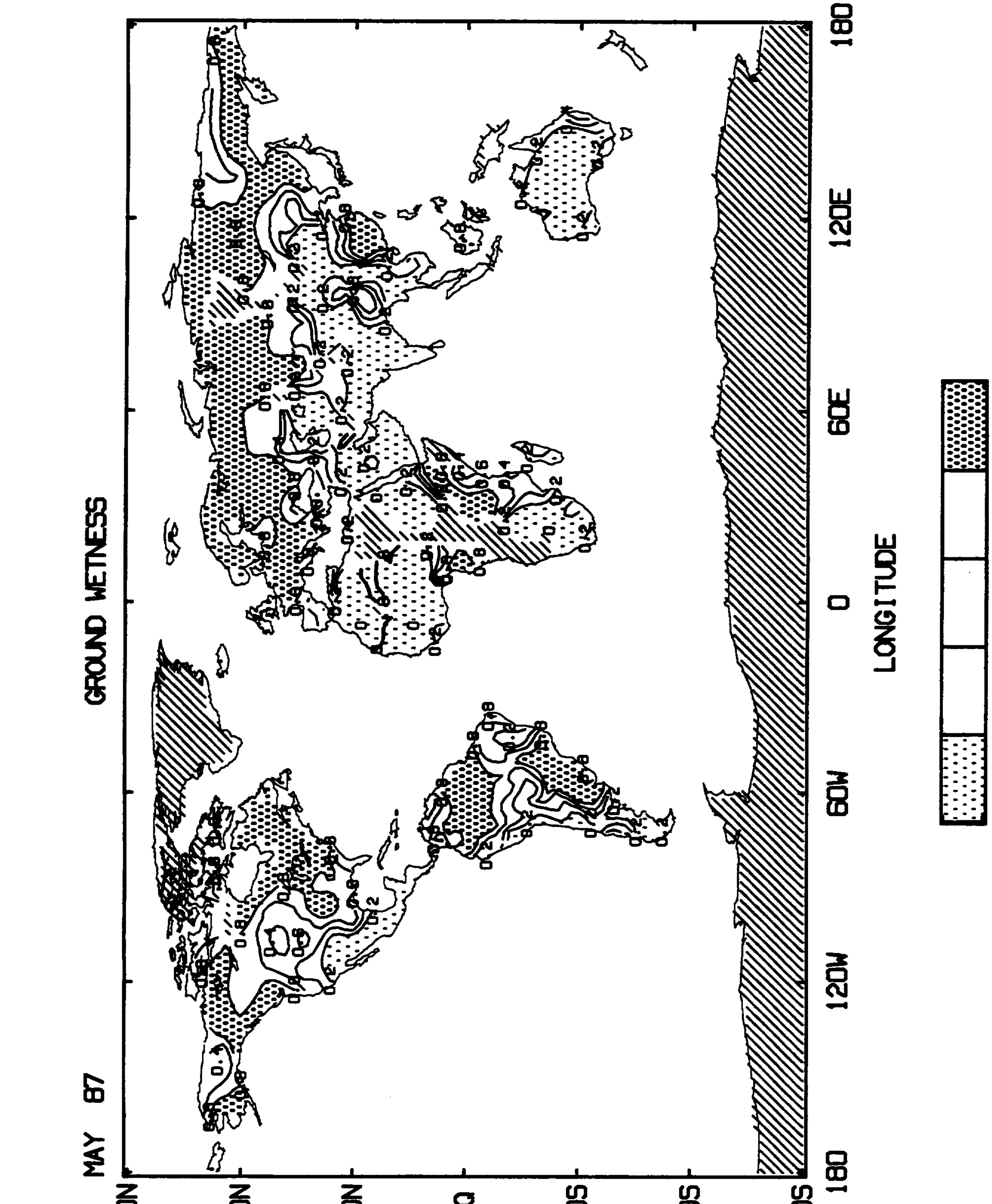

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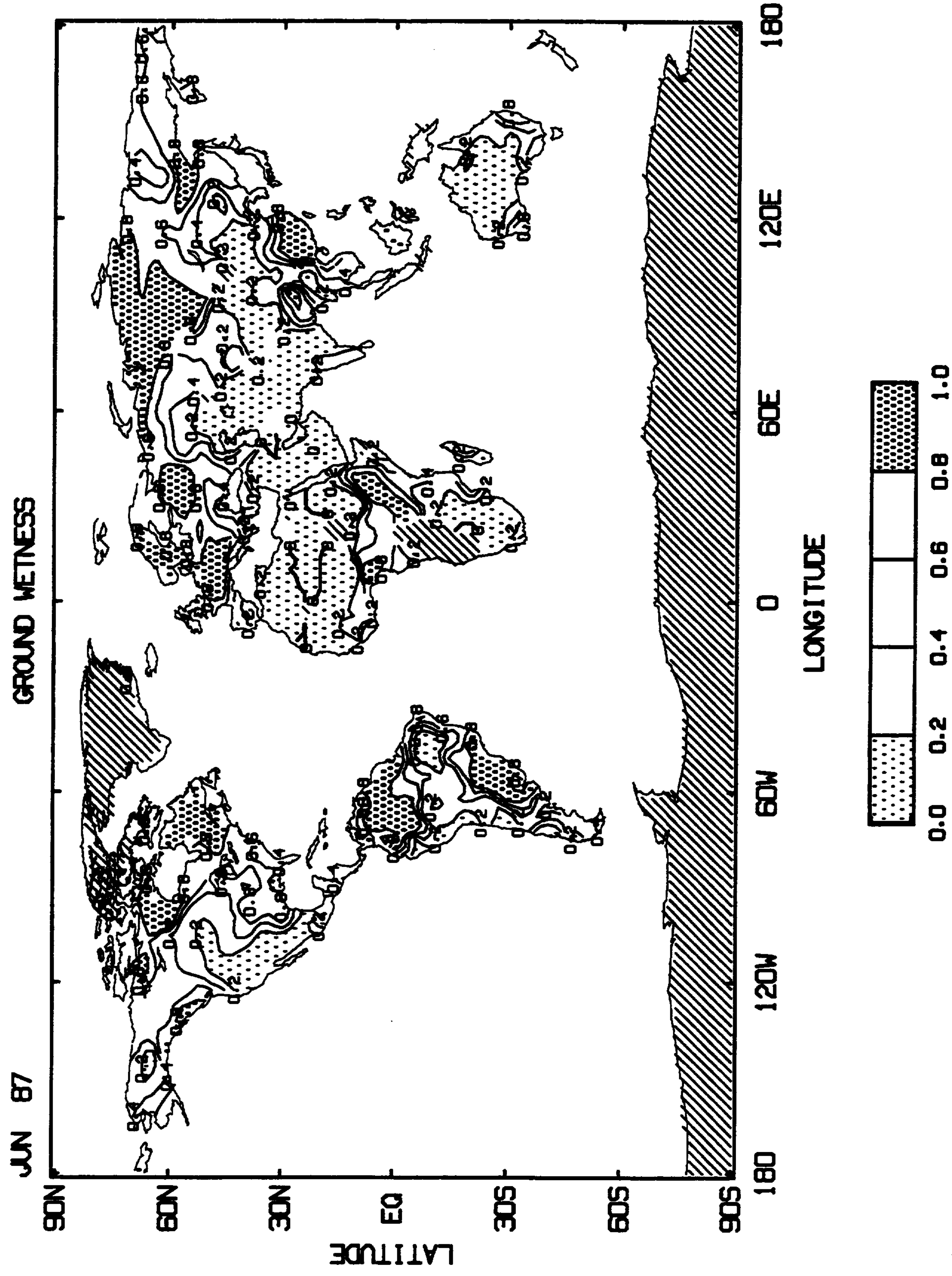
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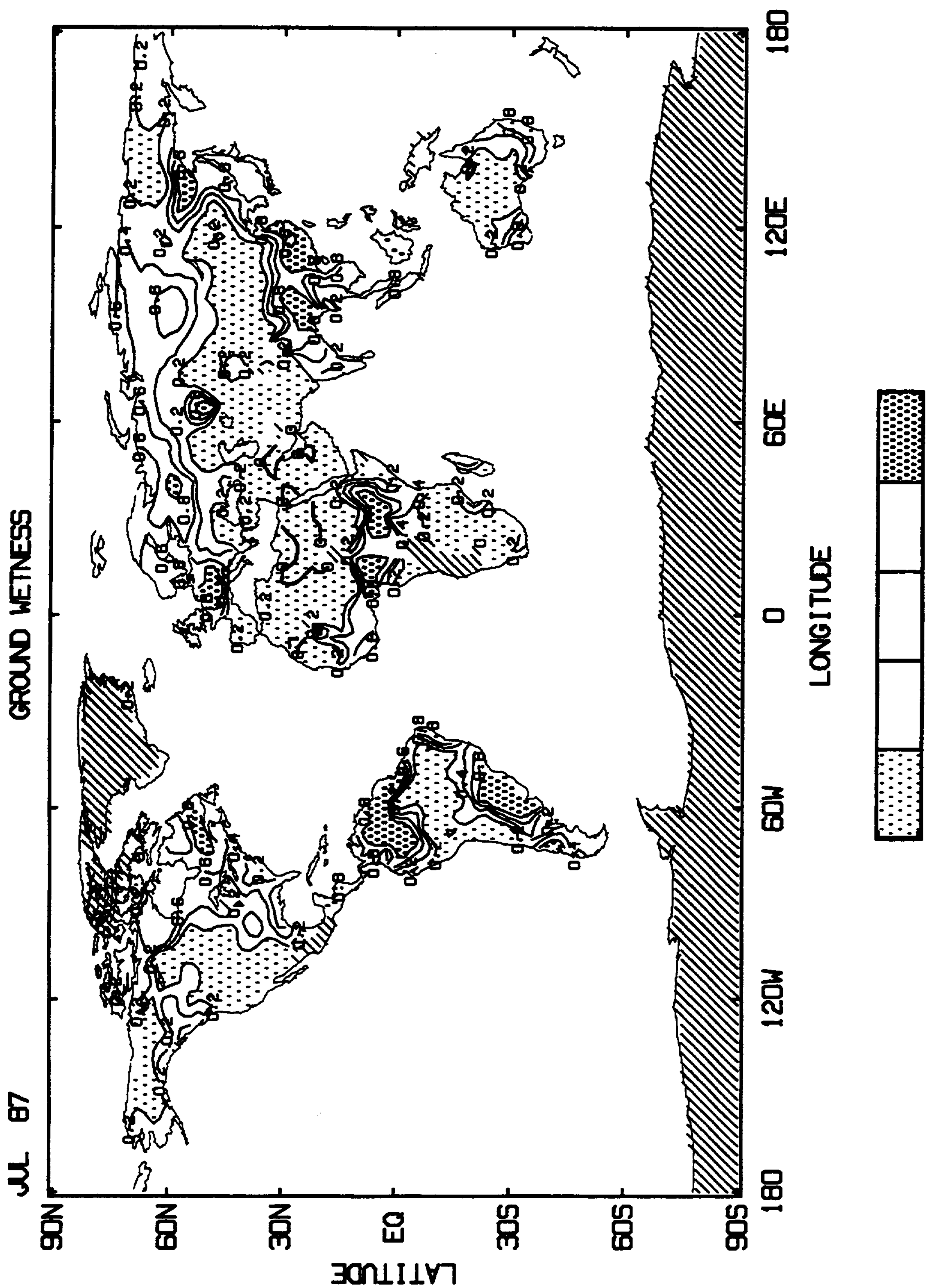

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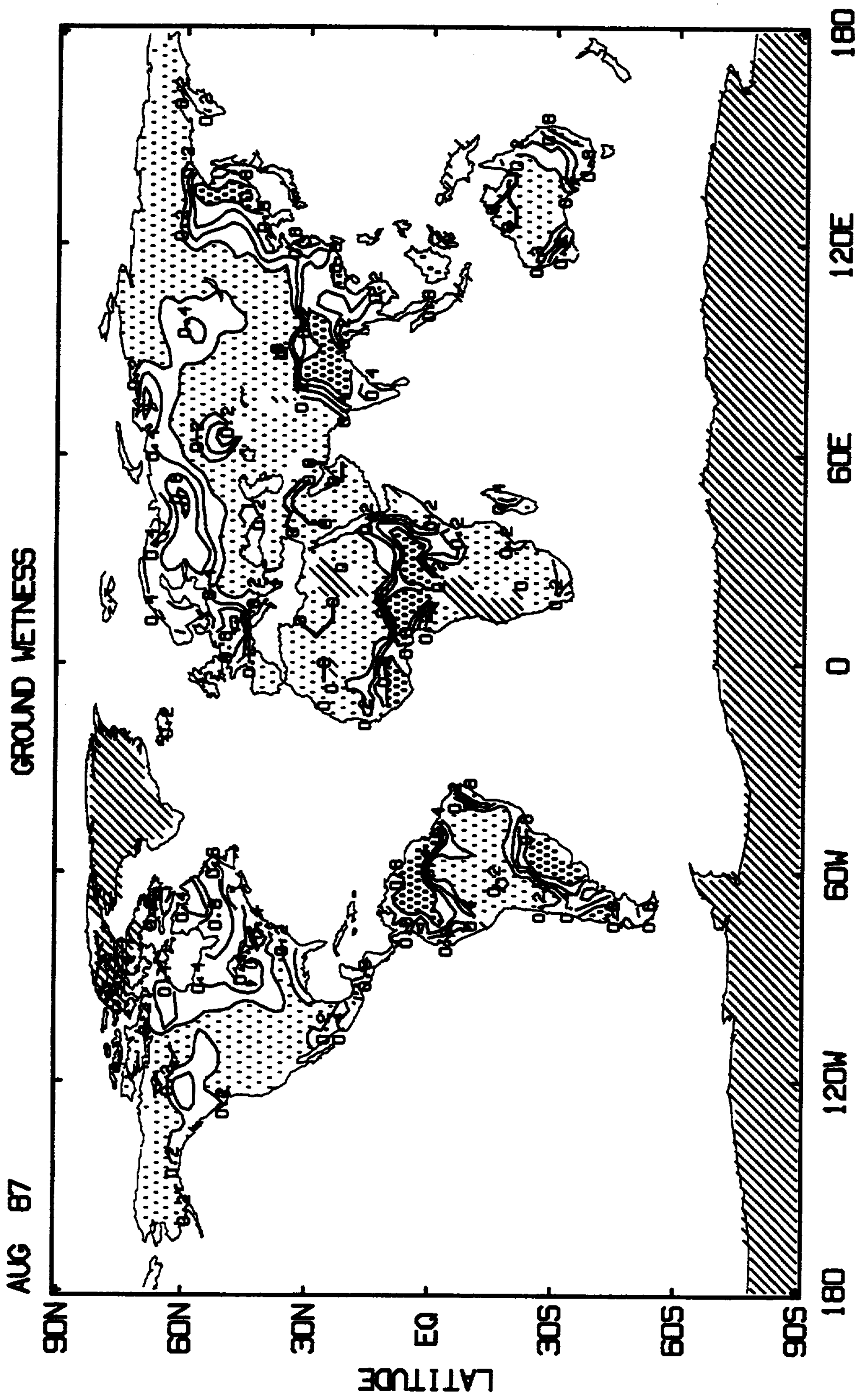
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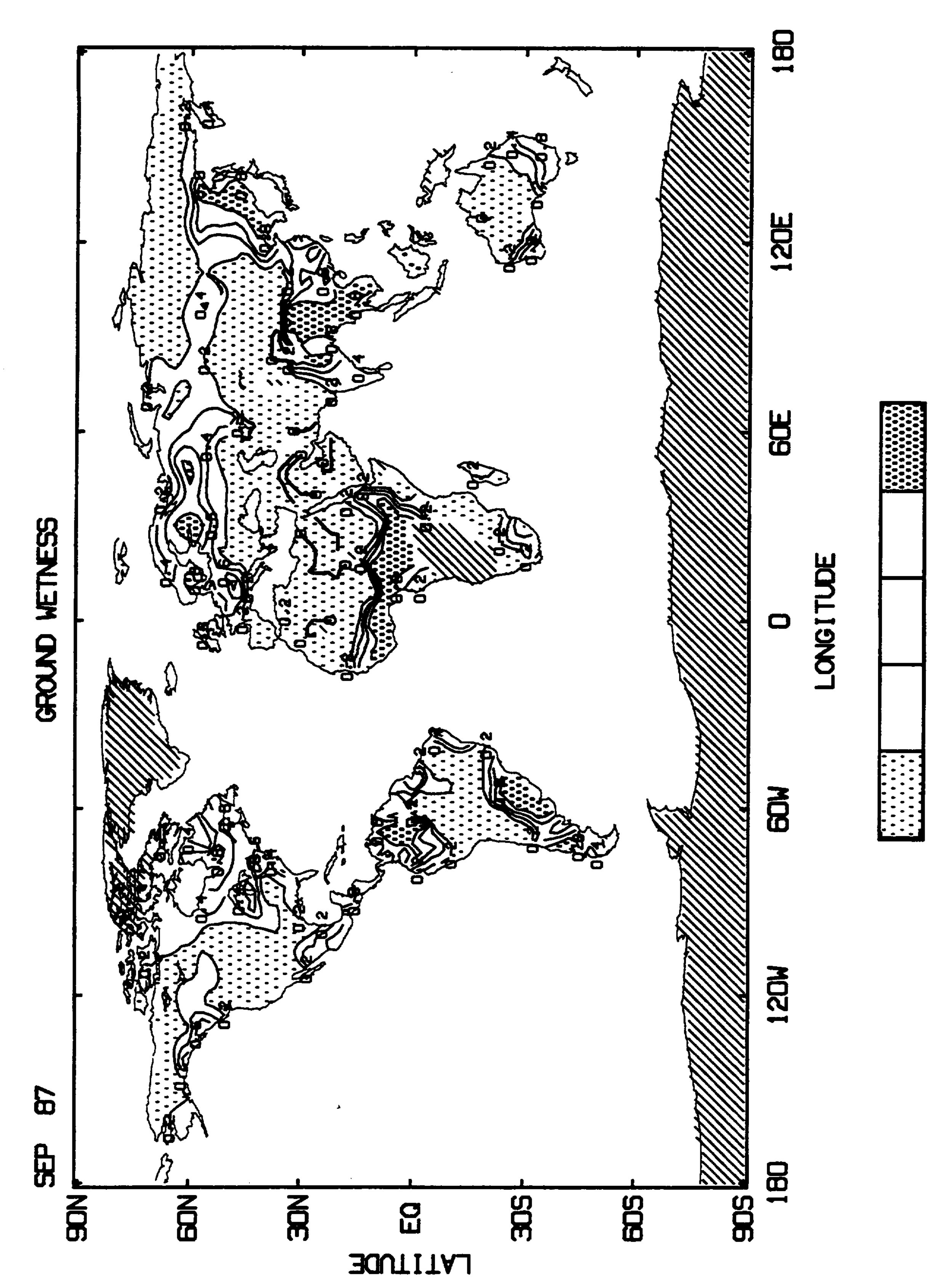
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GROUND WETNESS
90N
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30N
EQ
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60S
90S
LATITUDE
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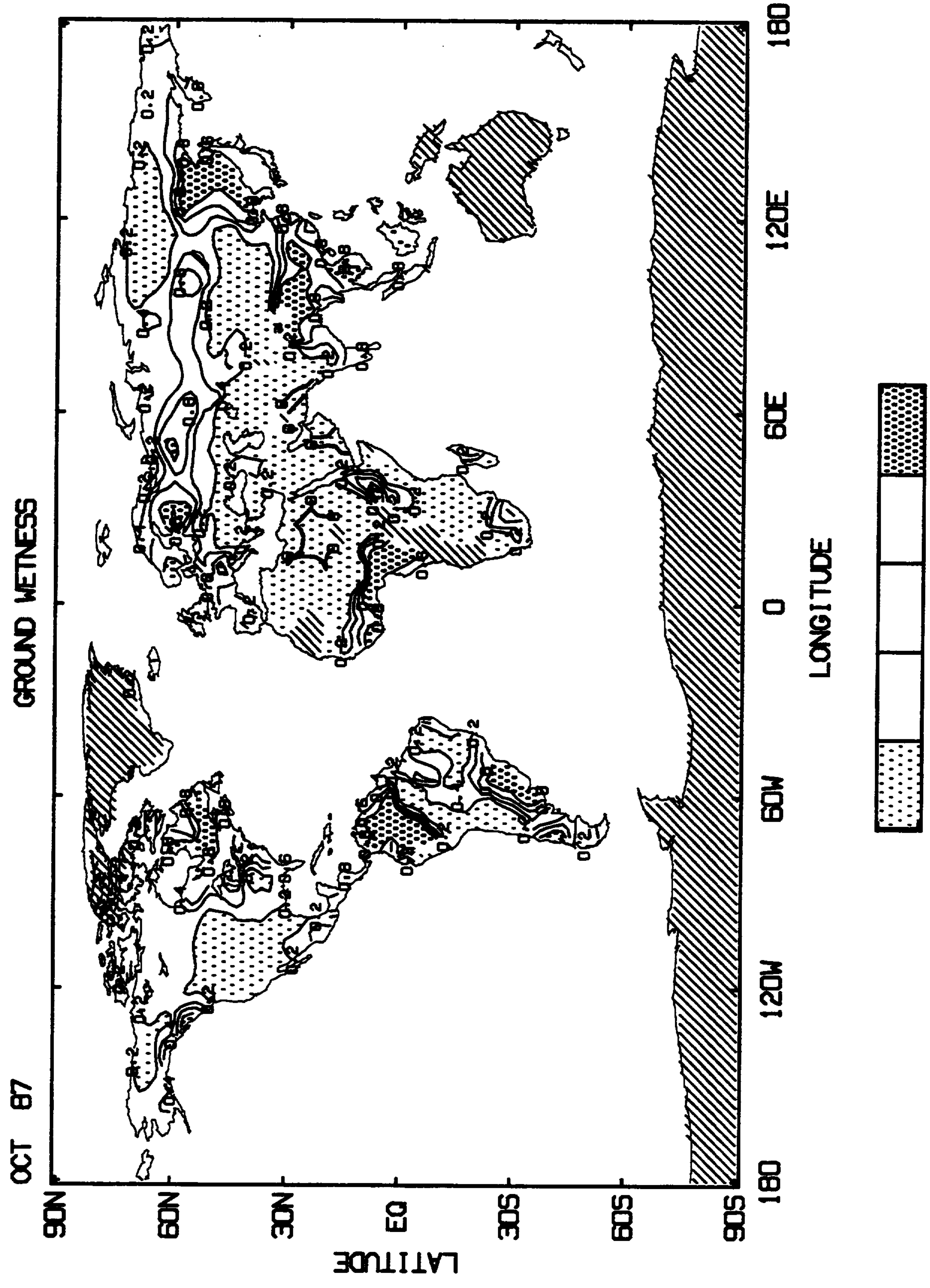

OCT 87
GROUND WETNESS
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EQ
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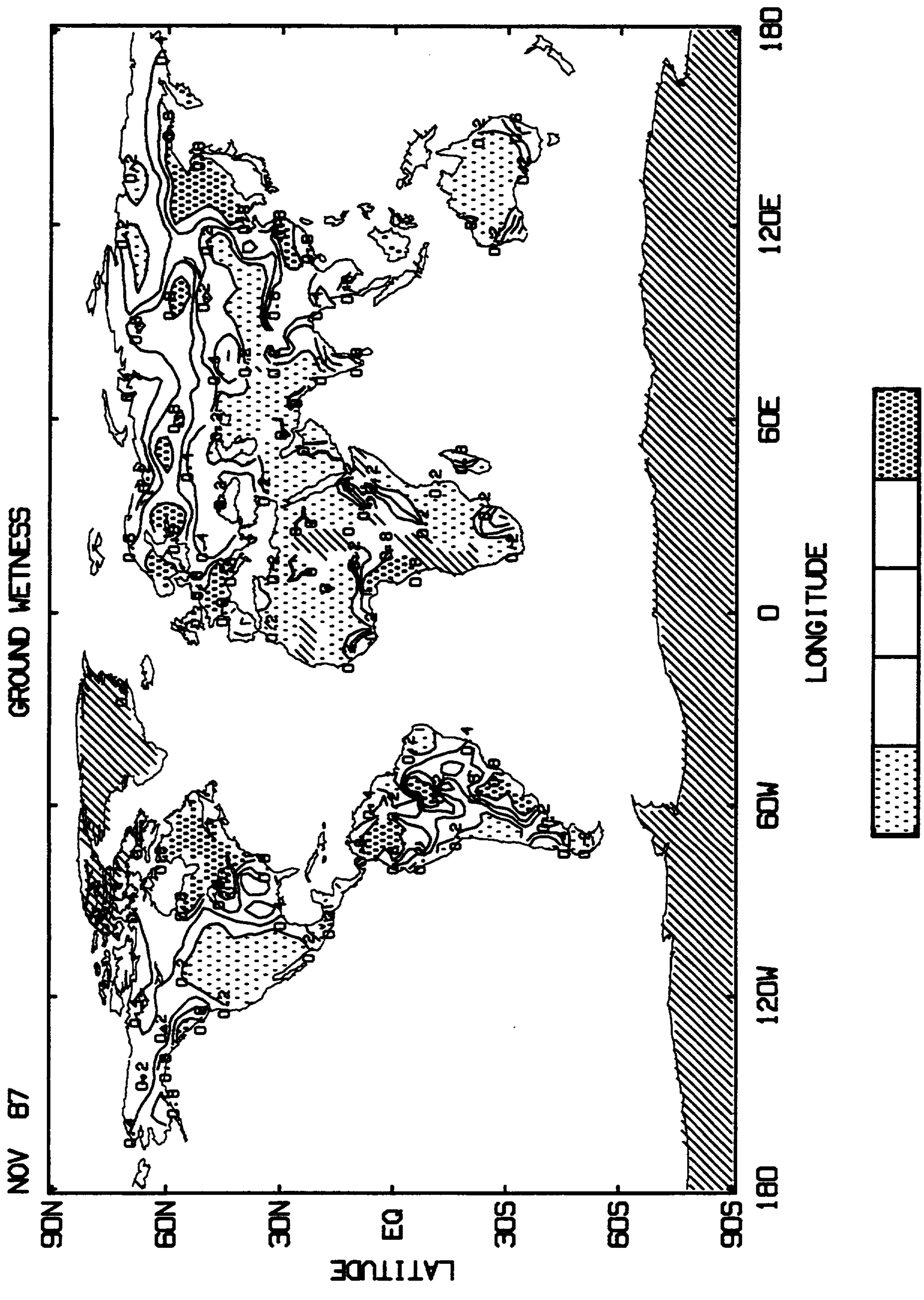
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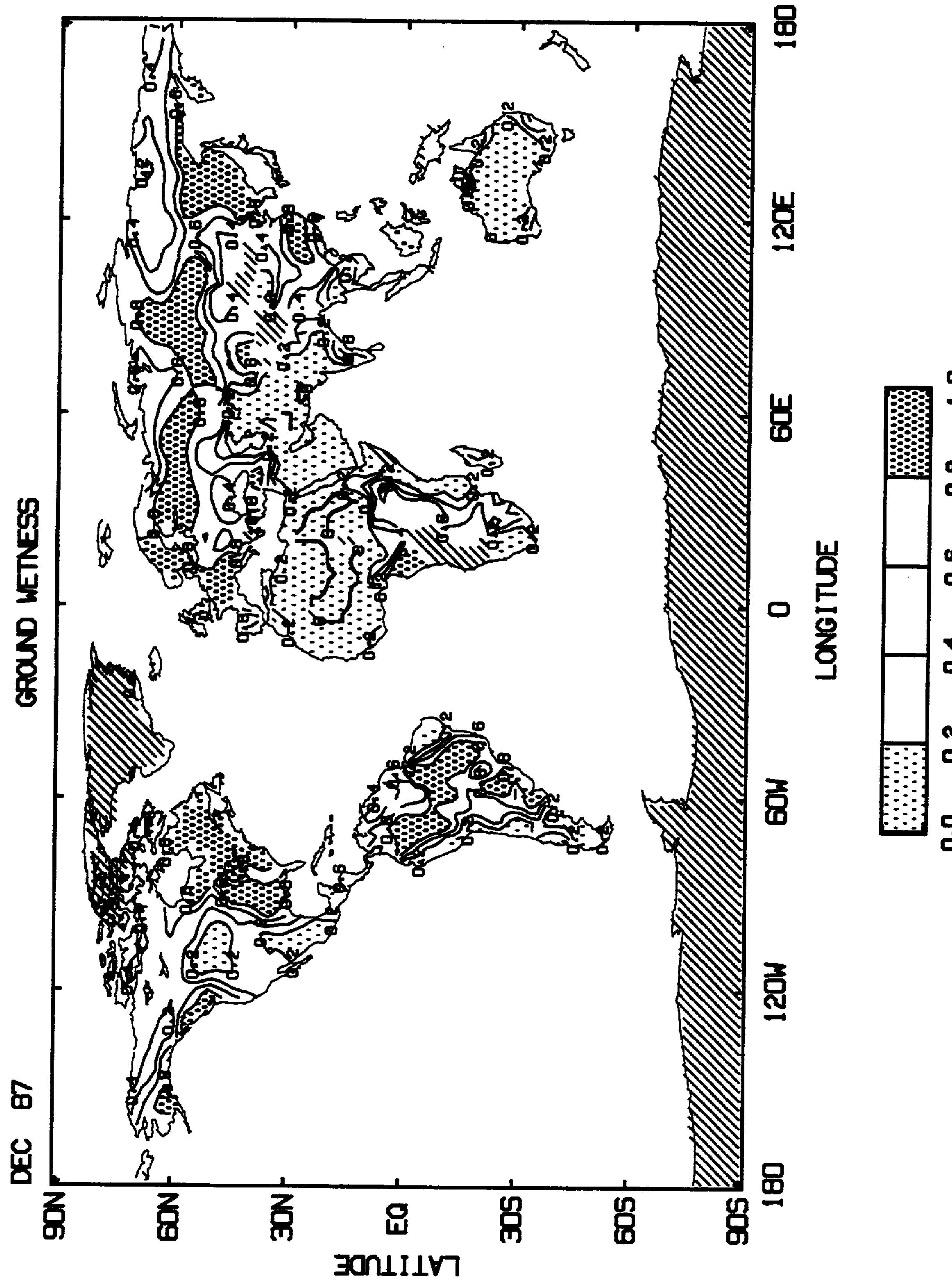
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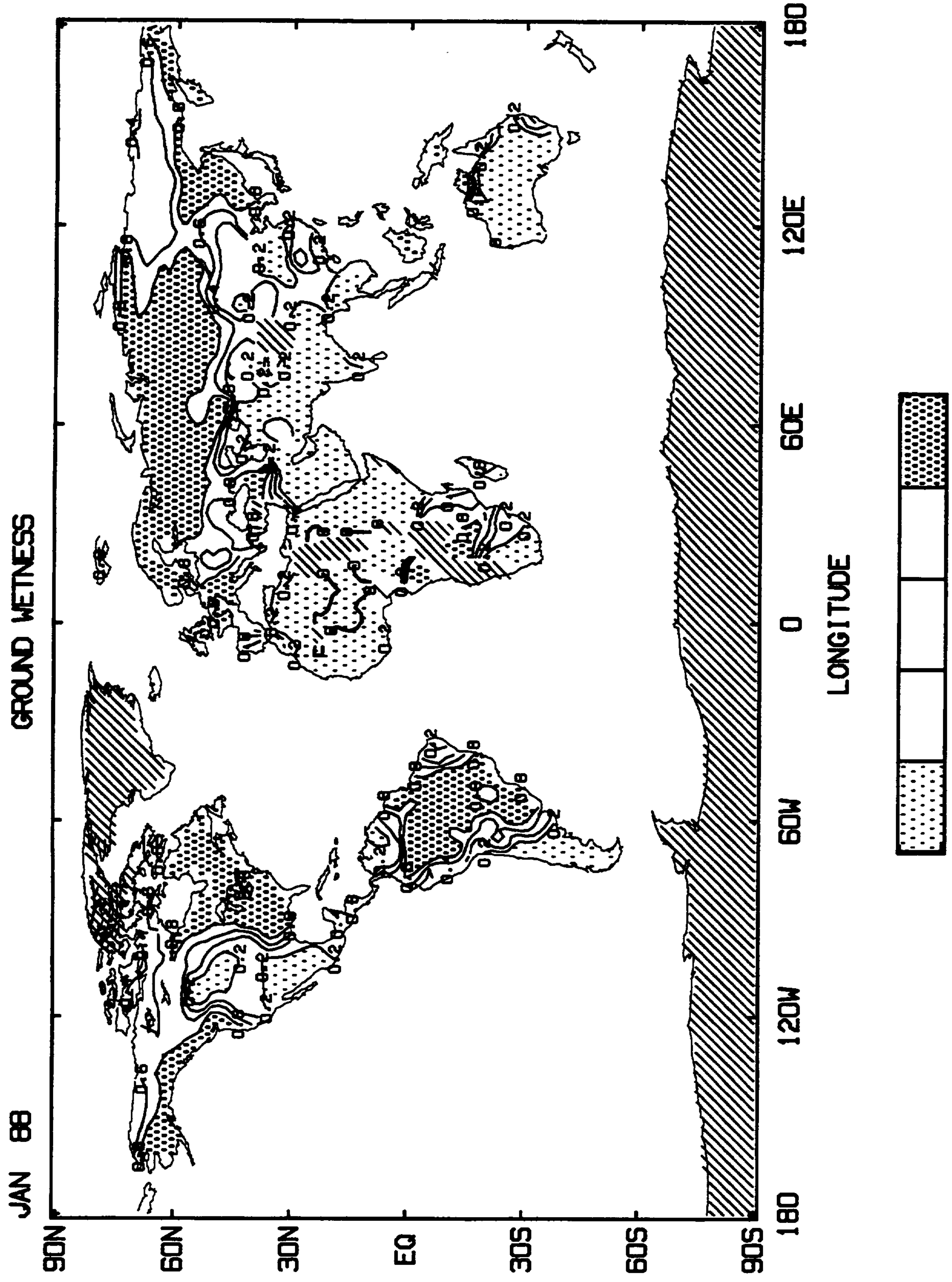
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GROUND WETNESS
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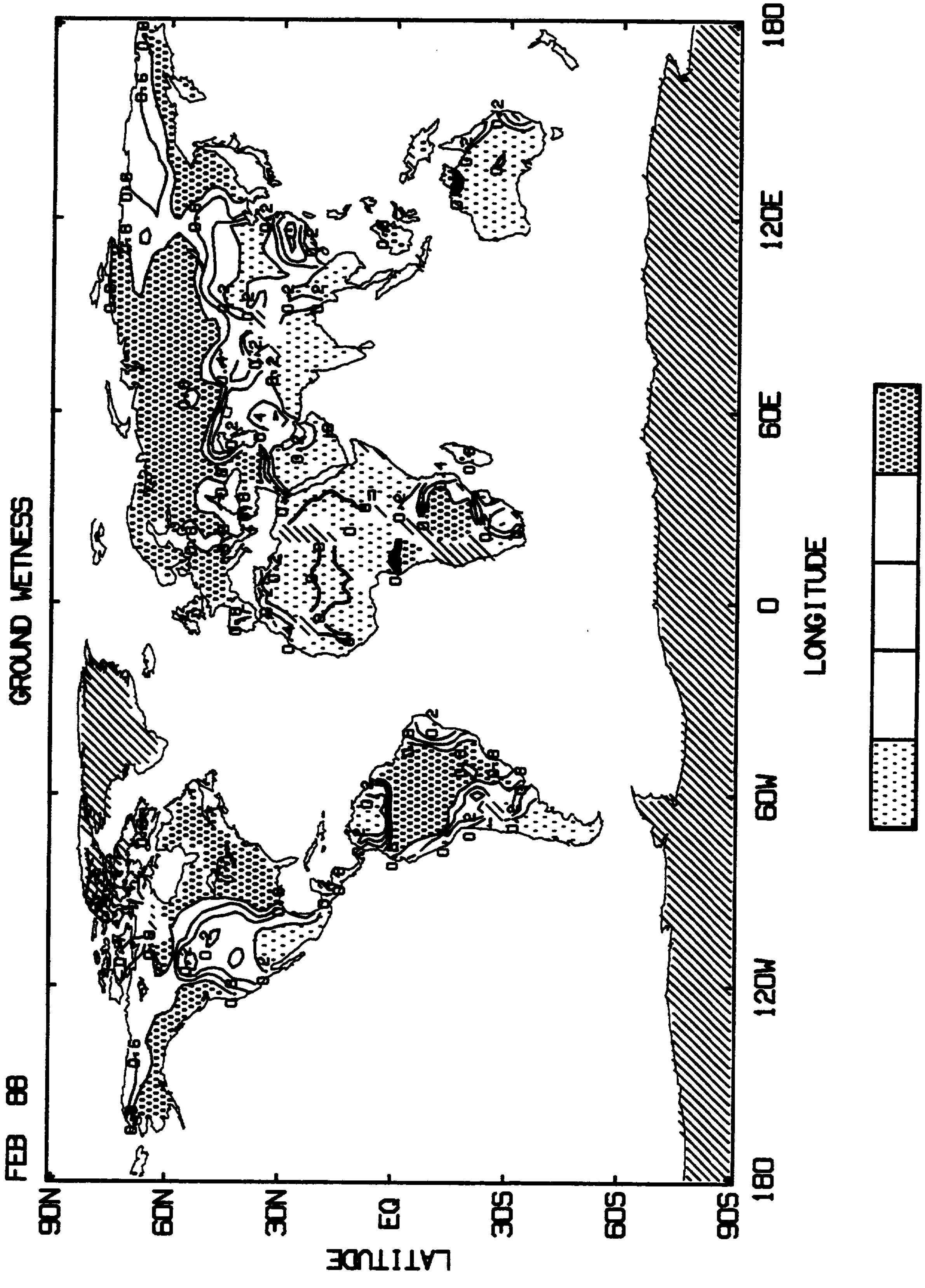
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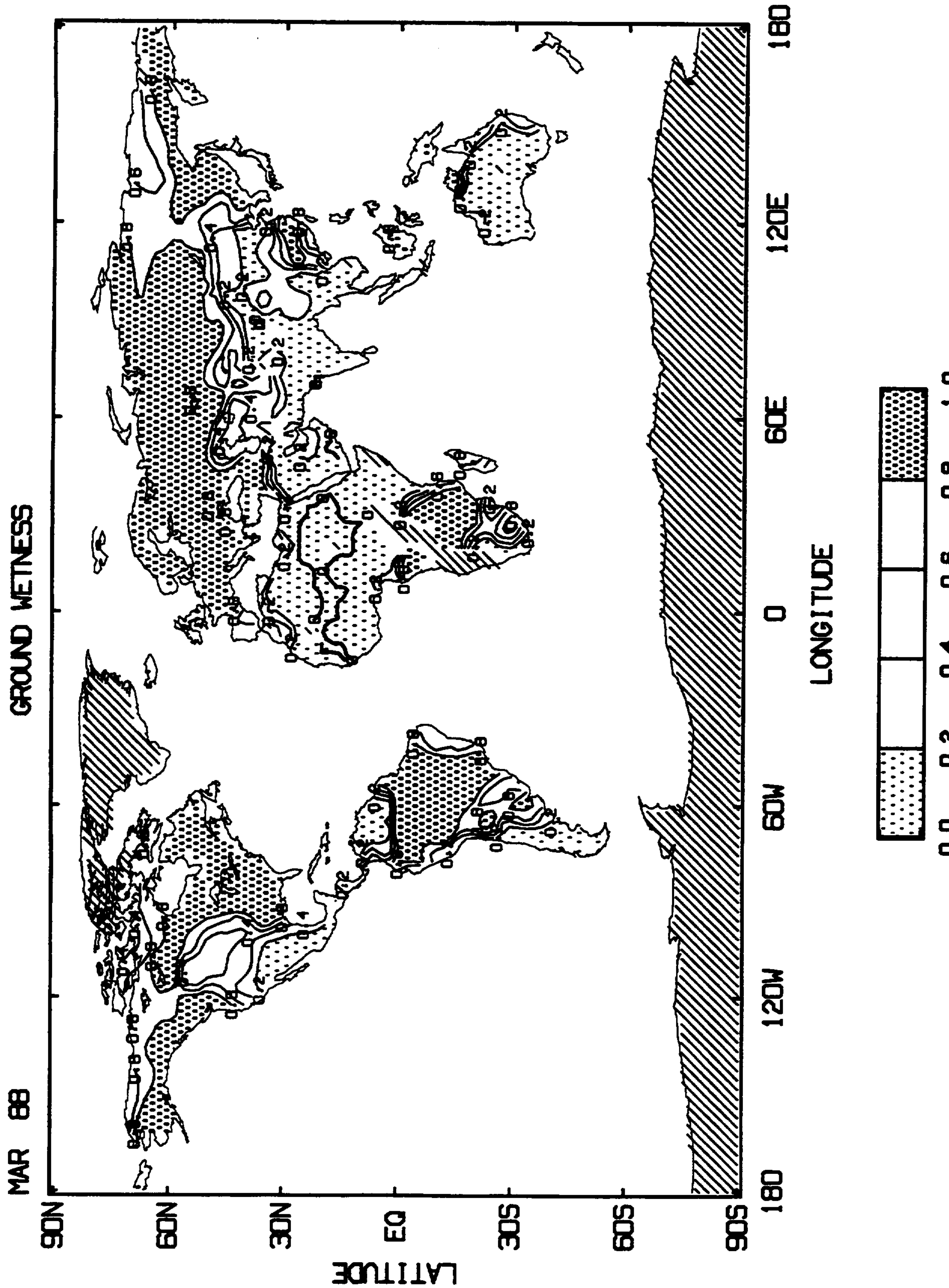

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GROUND WETNESS
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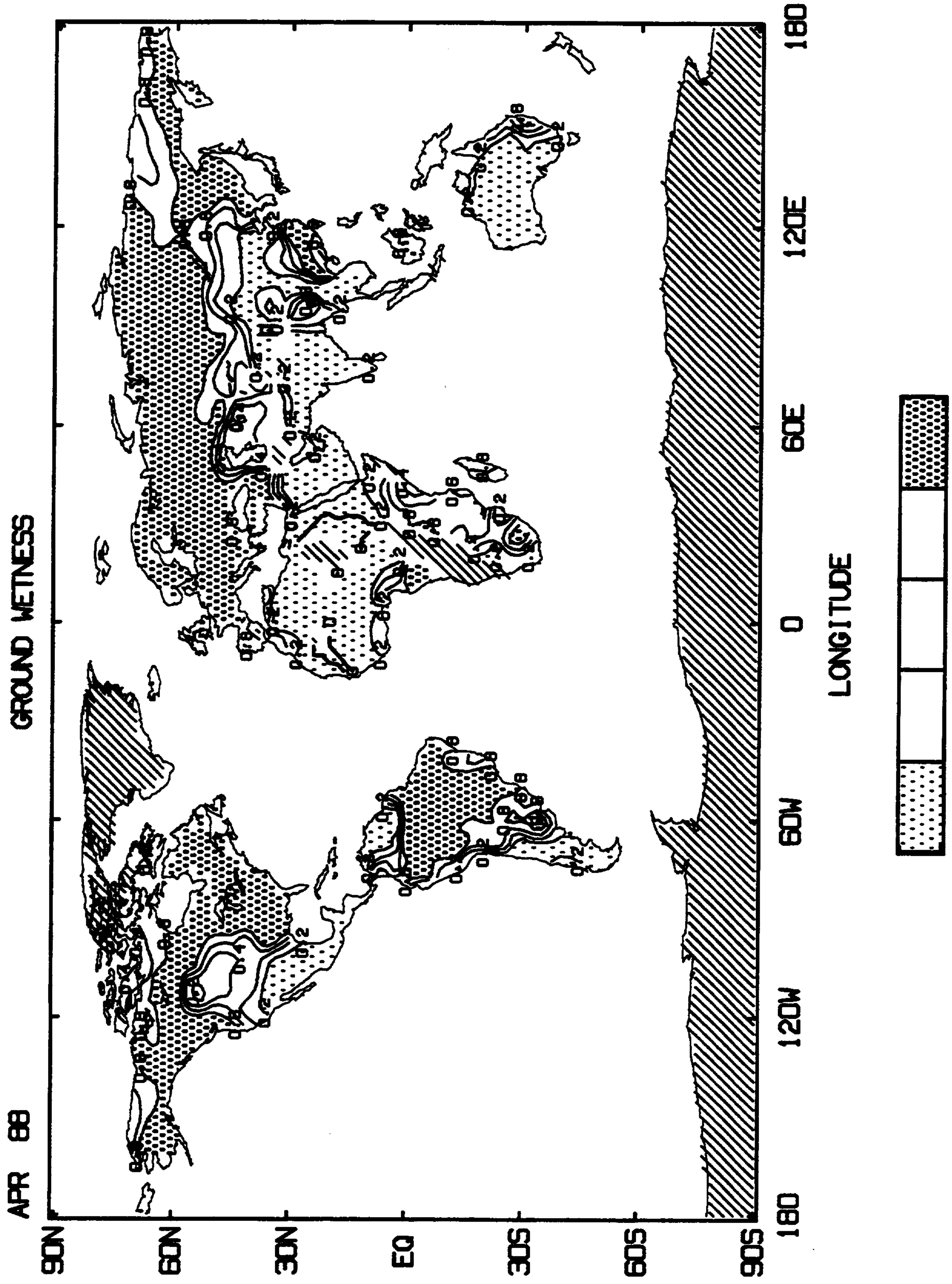

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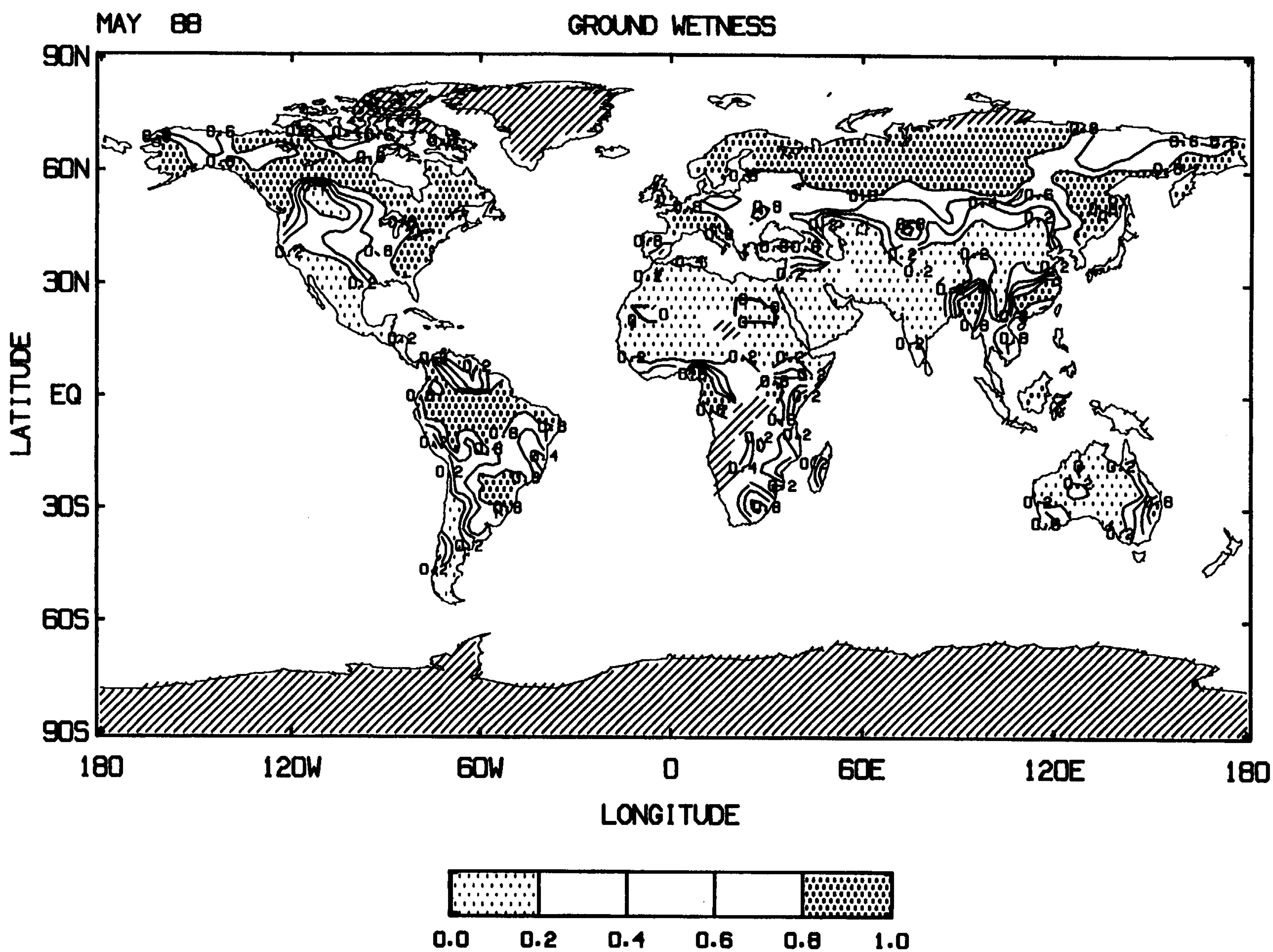

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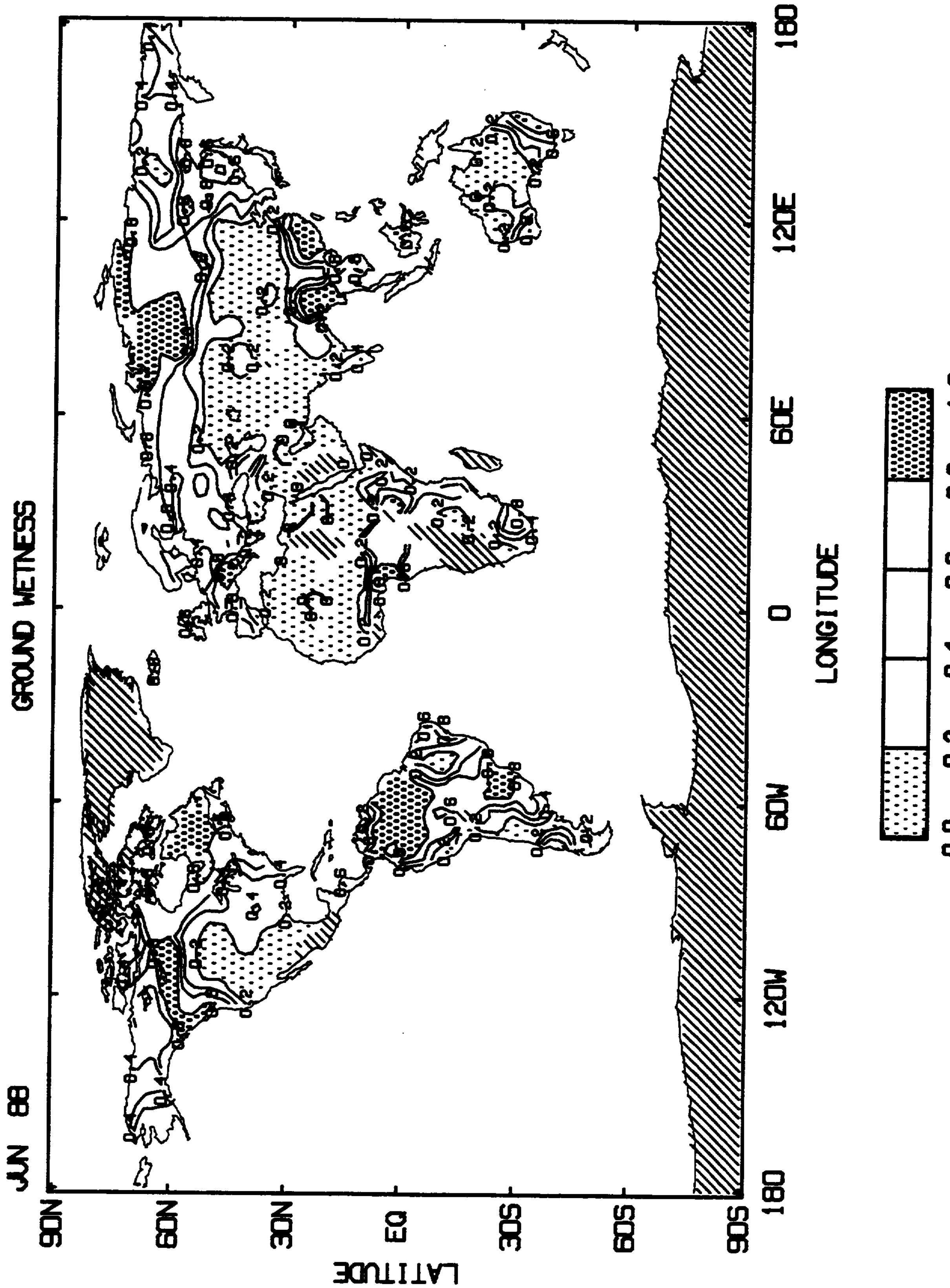
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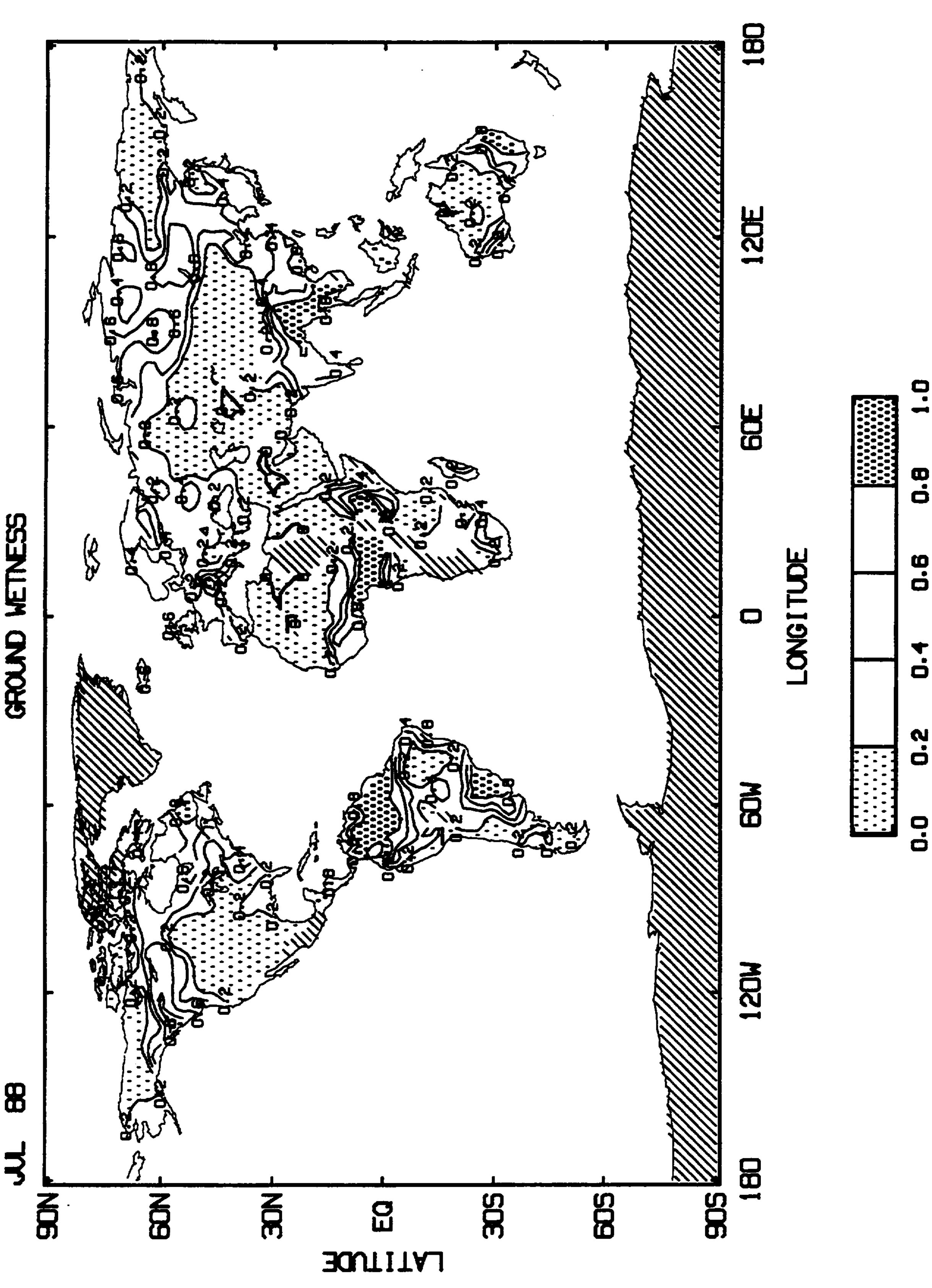
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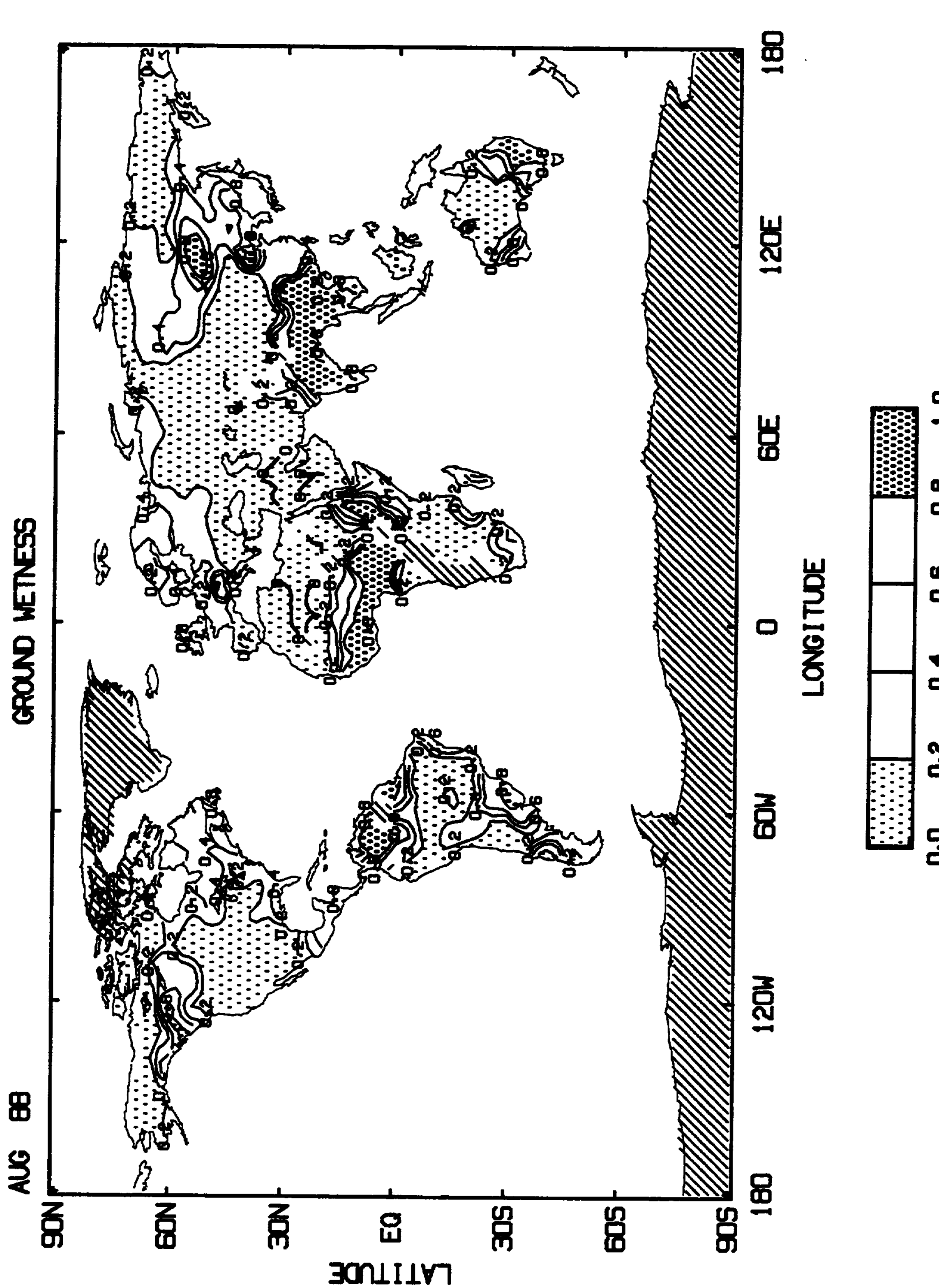
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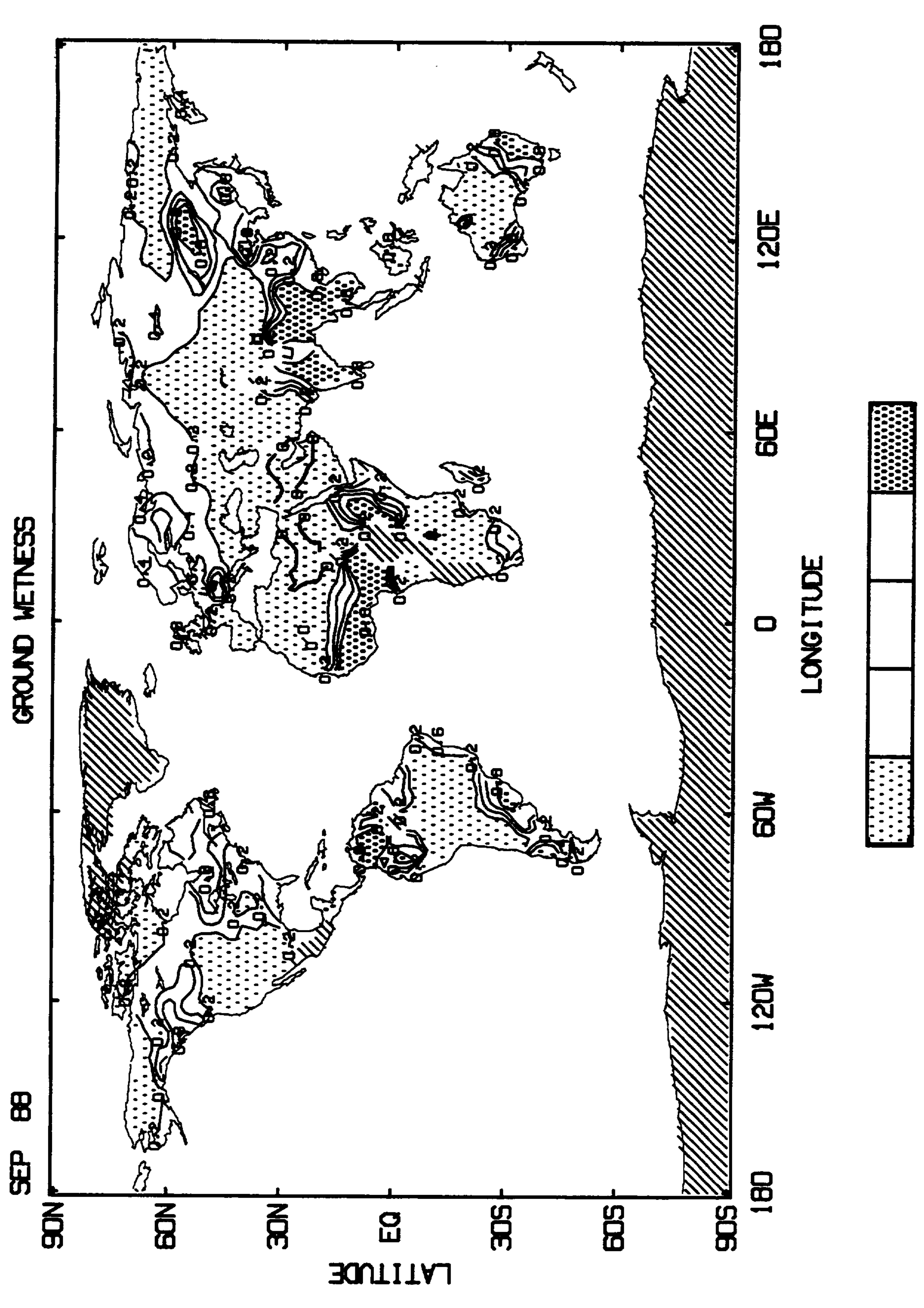
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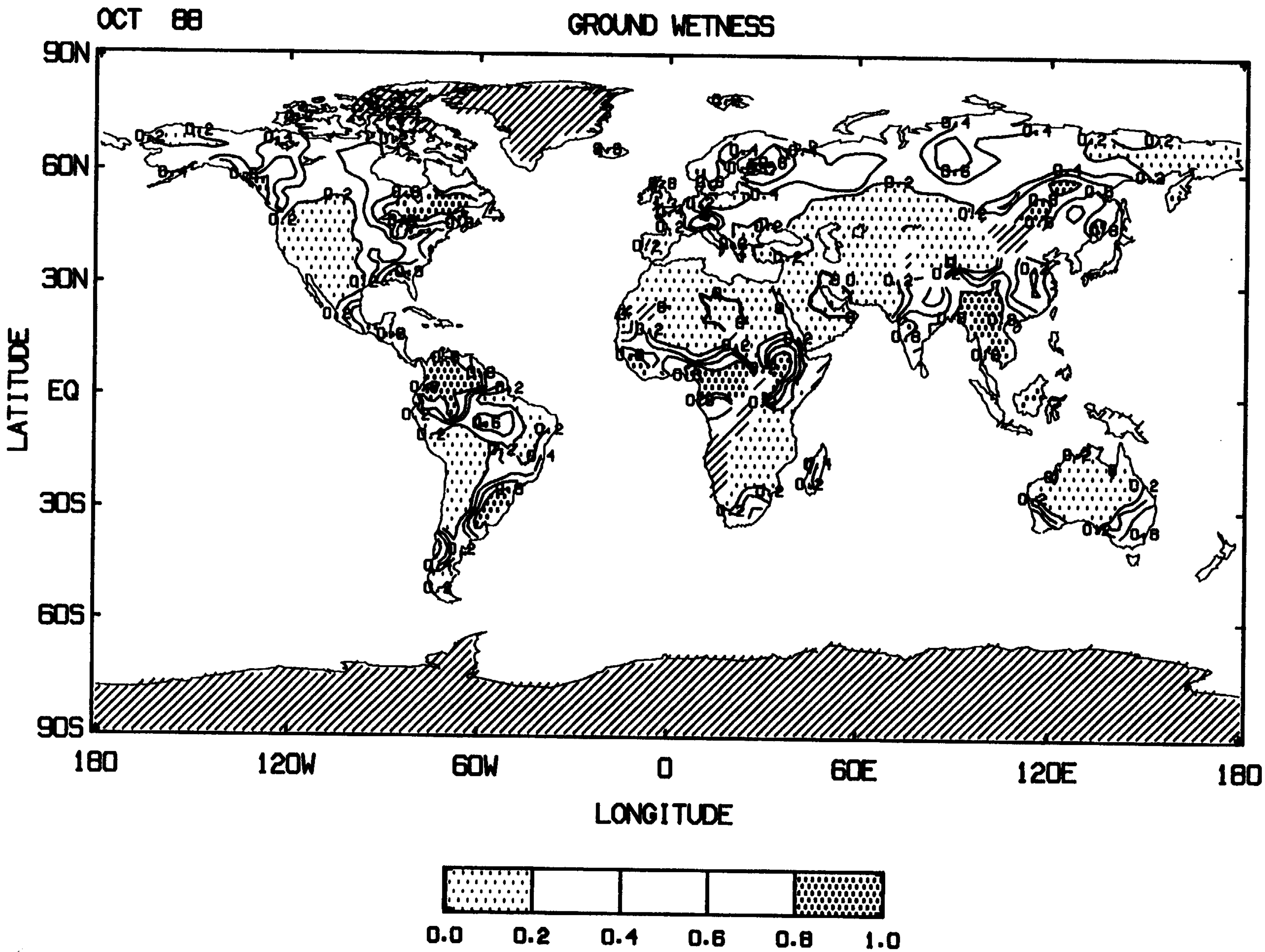

OCT 88
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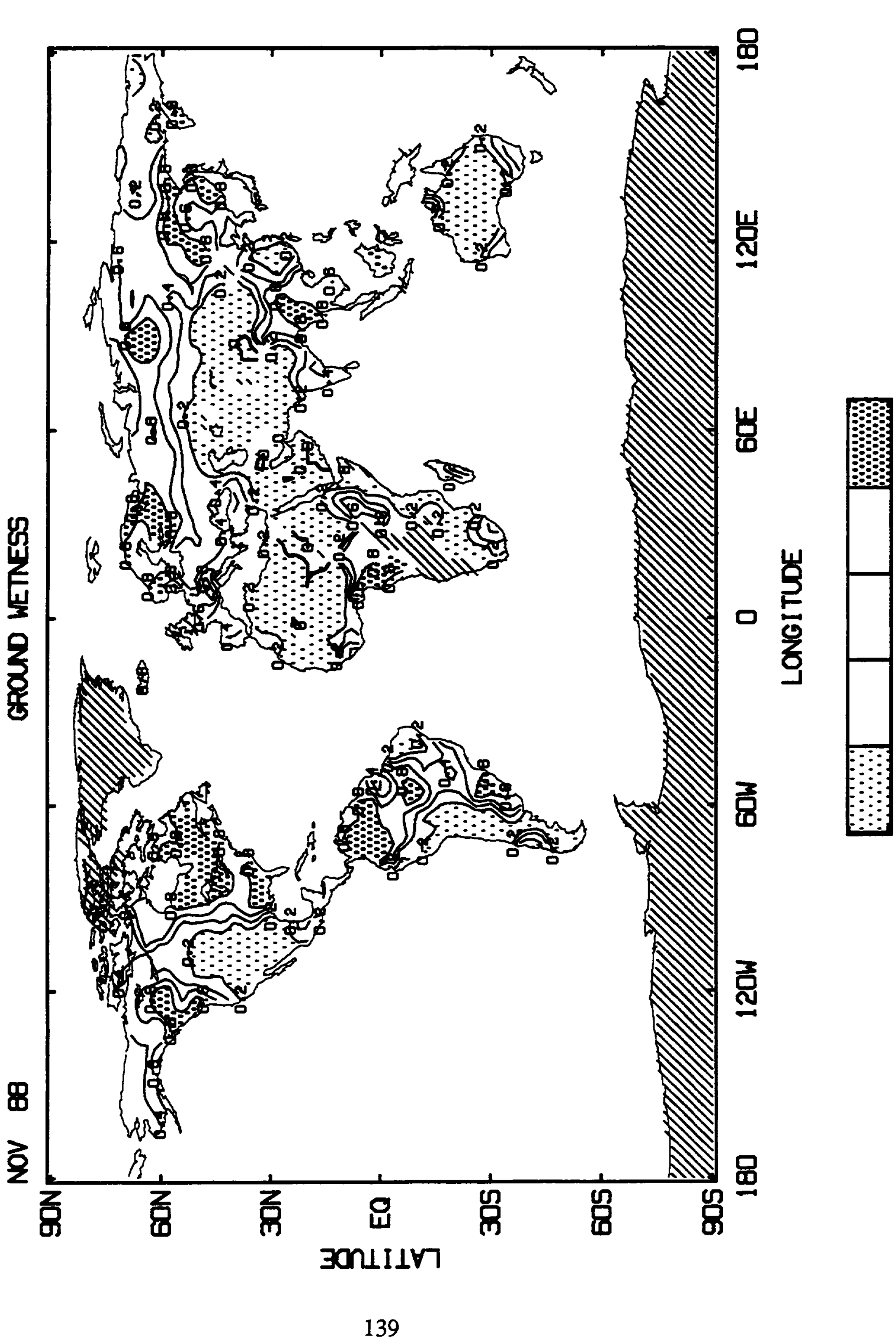

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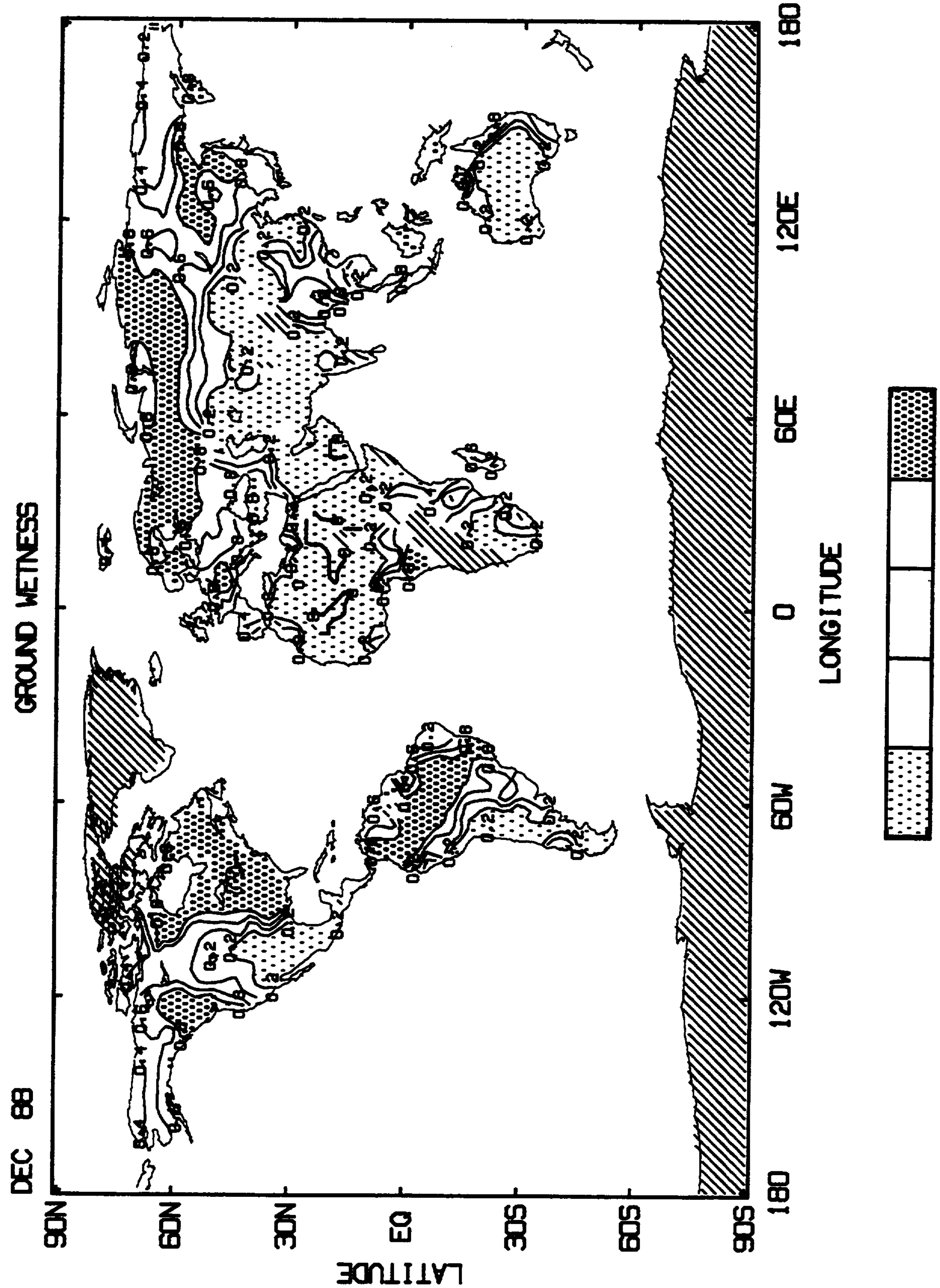
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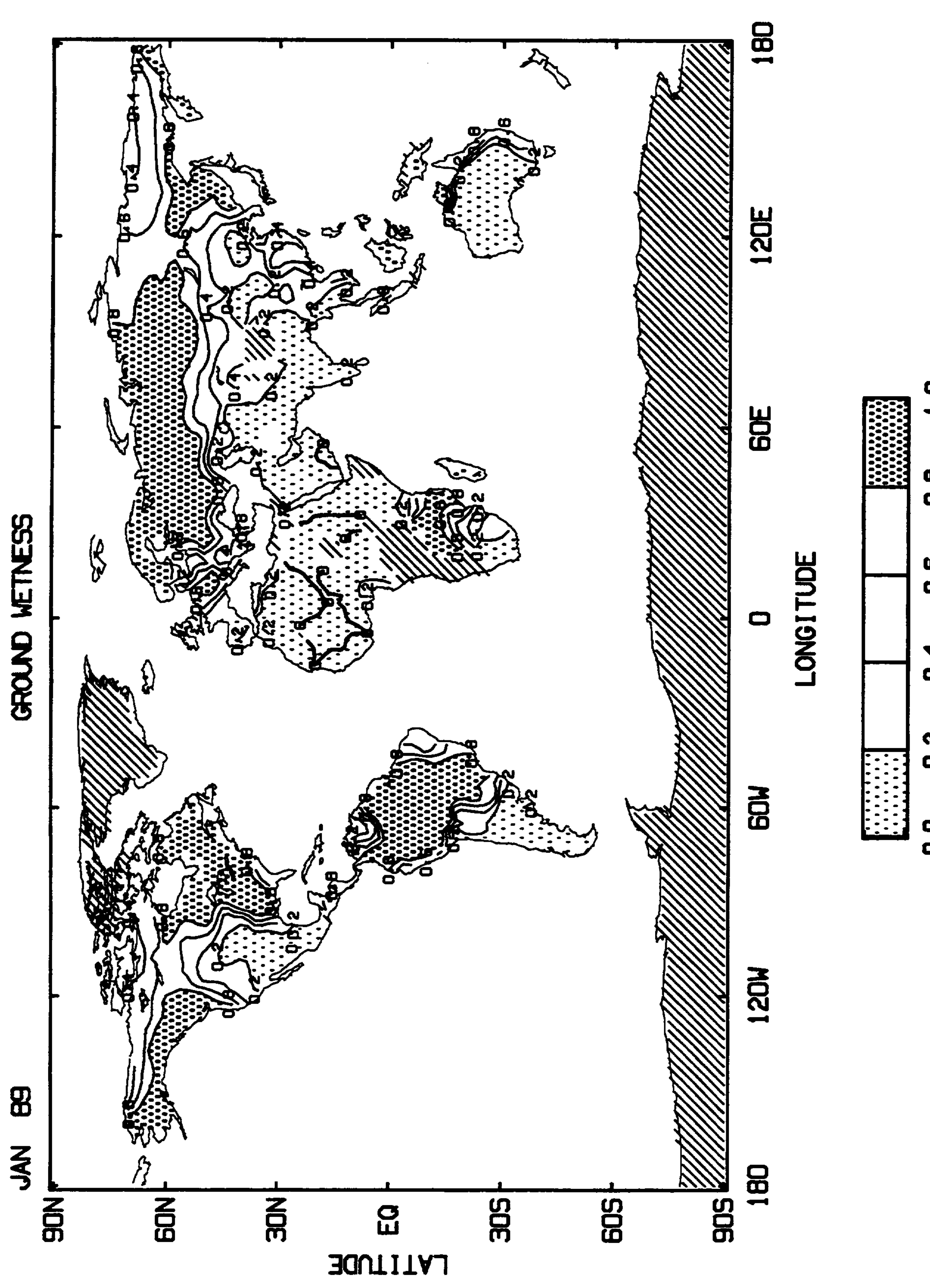
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GROUND WETNESS
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EQ
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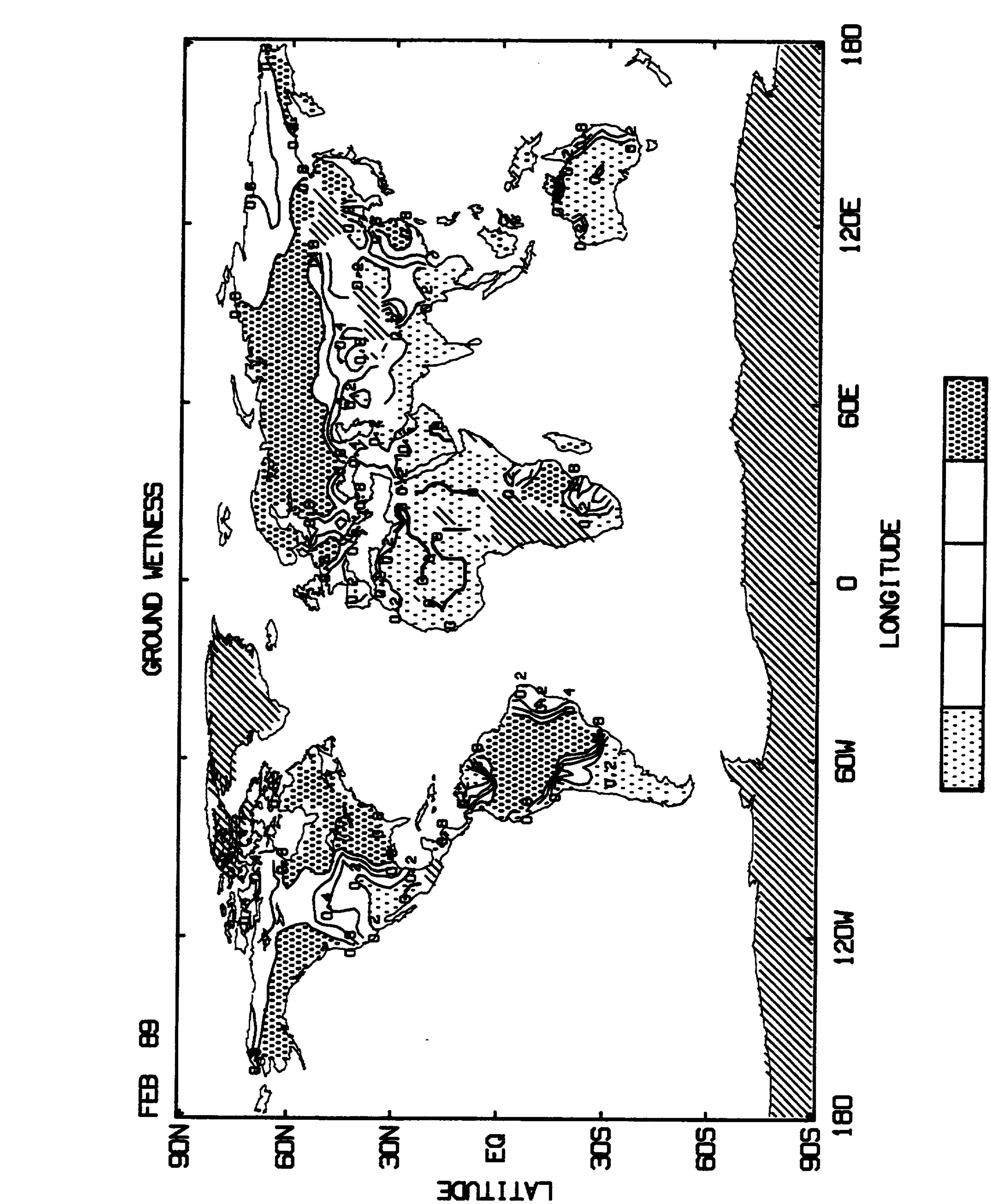
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GROUND WETNESS
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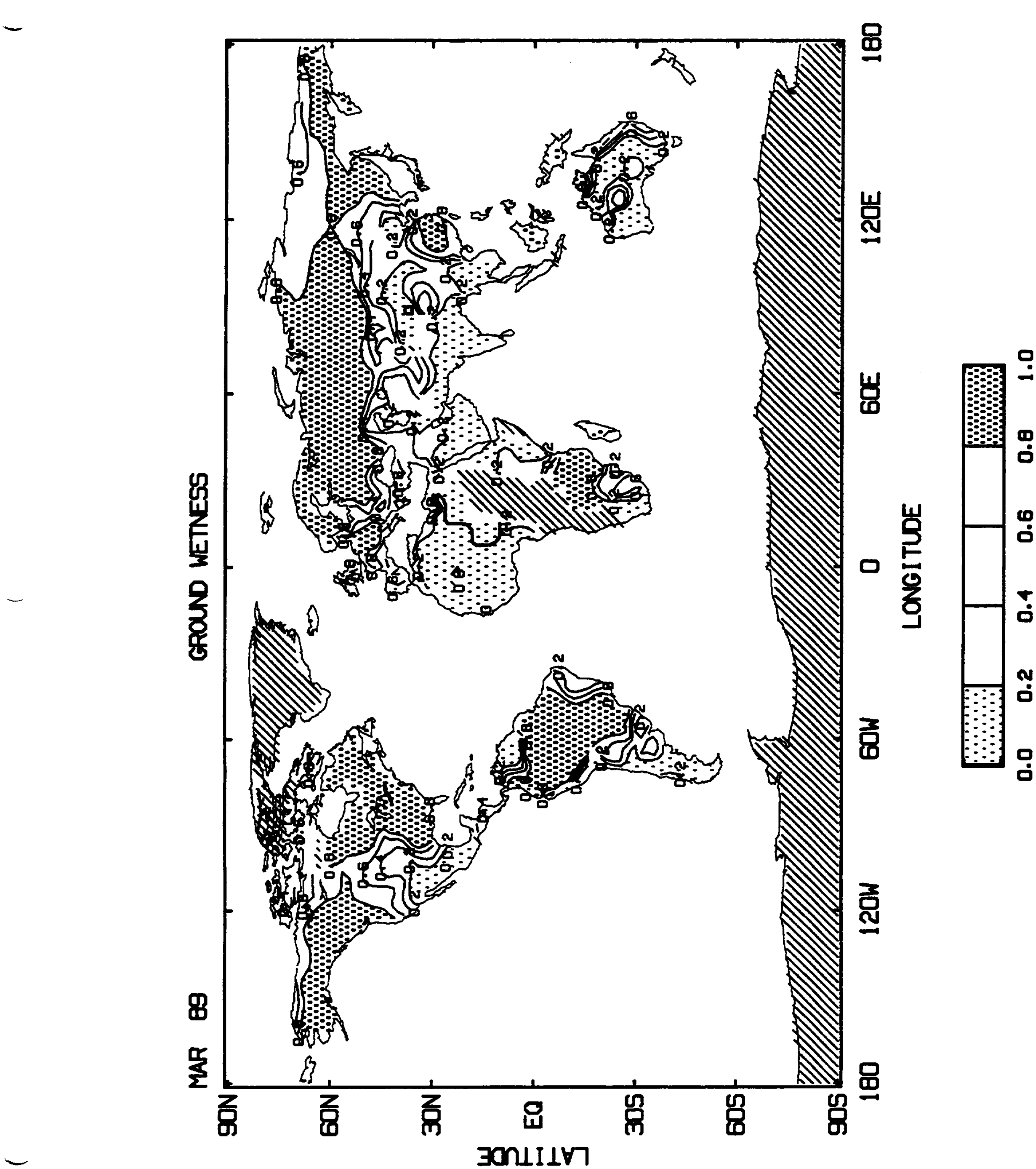

MAR 89
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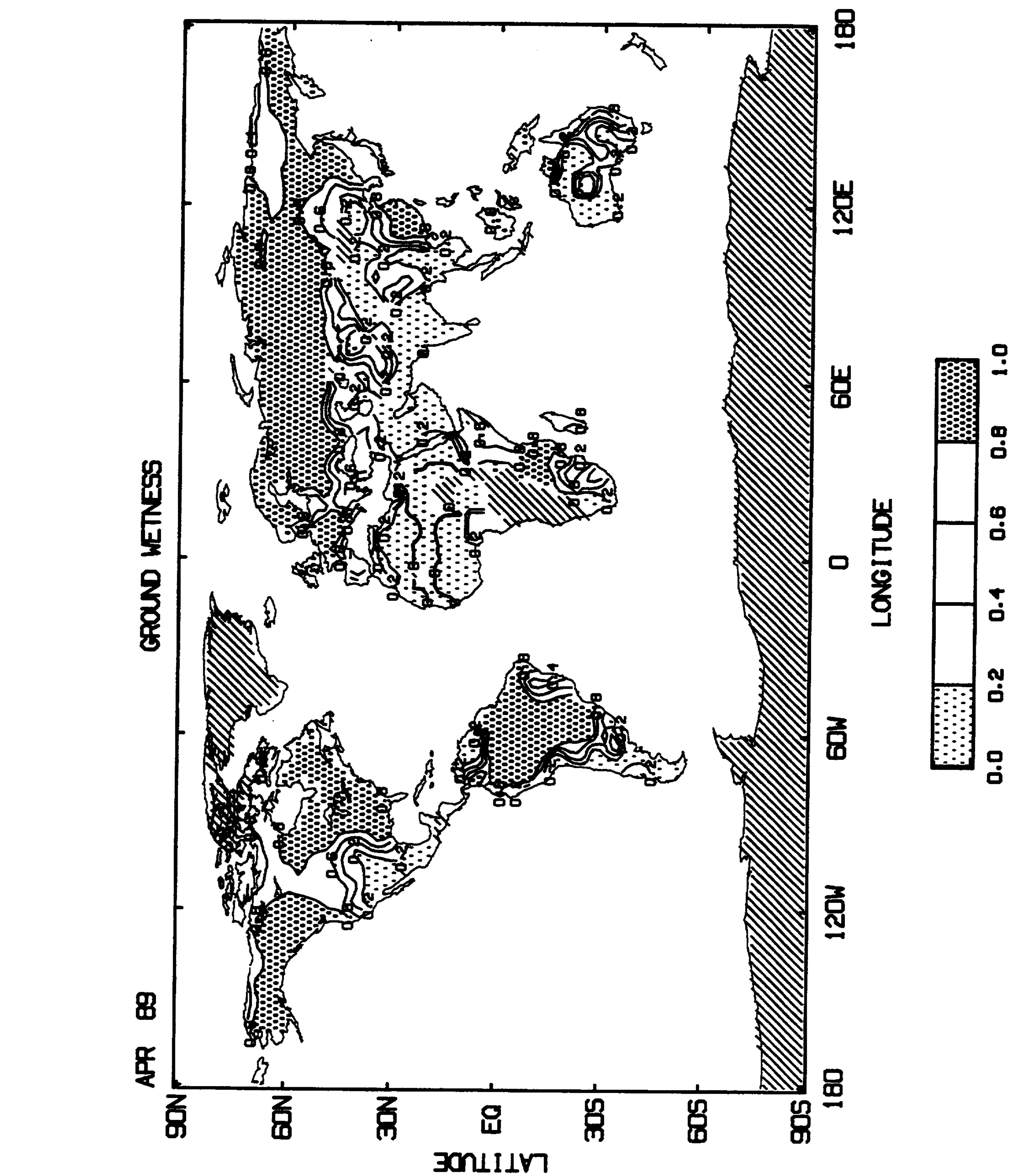
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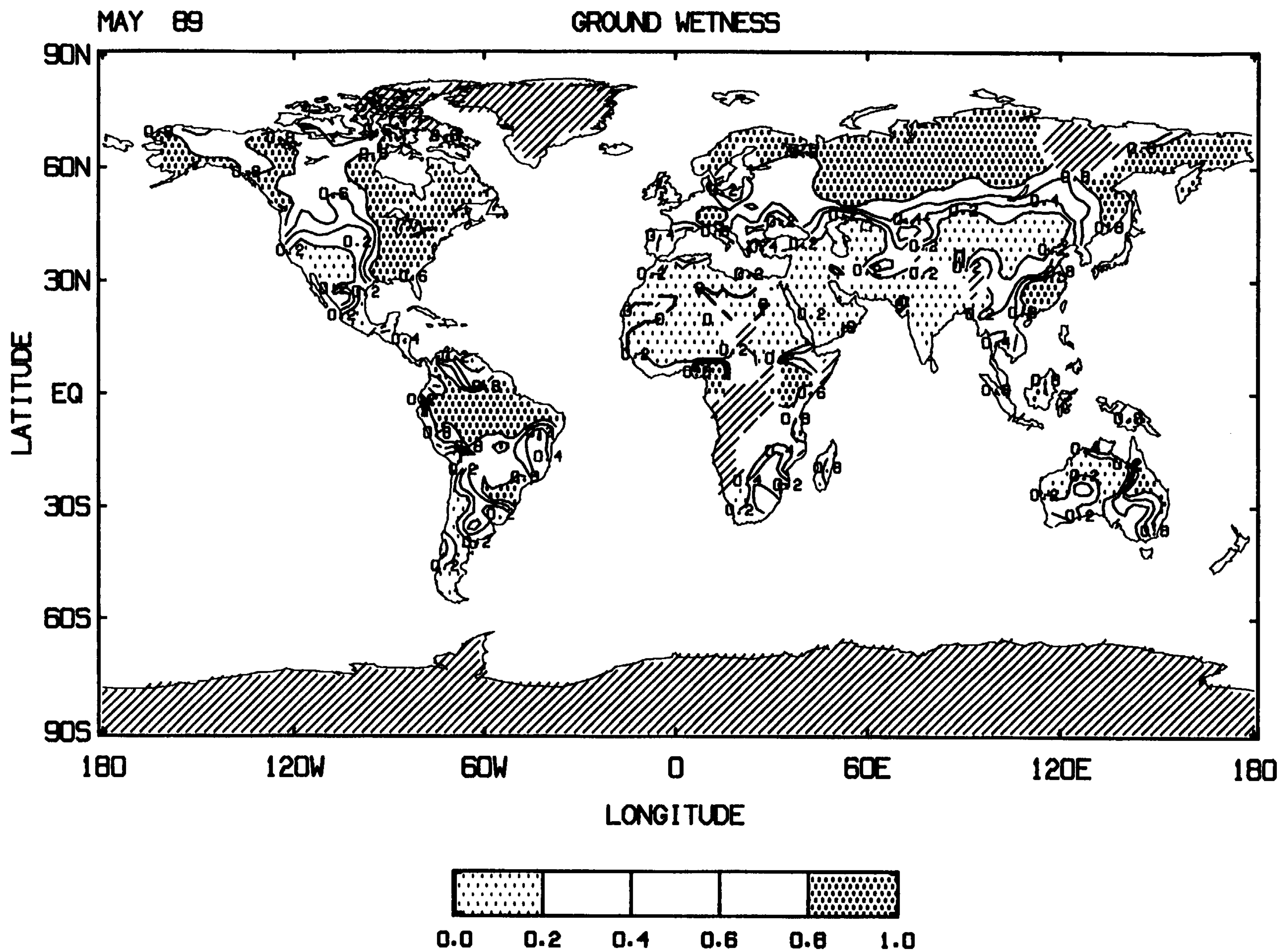
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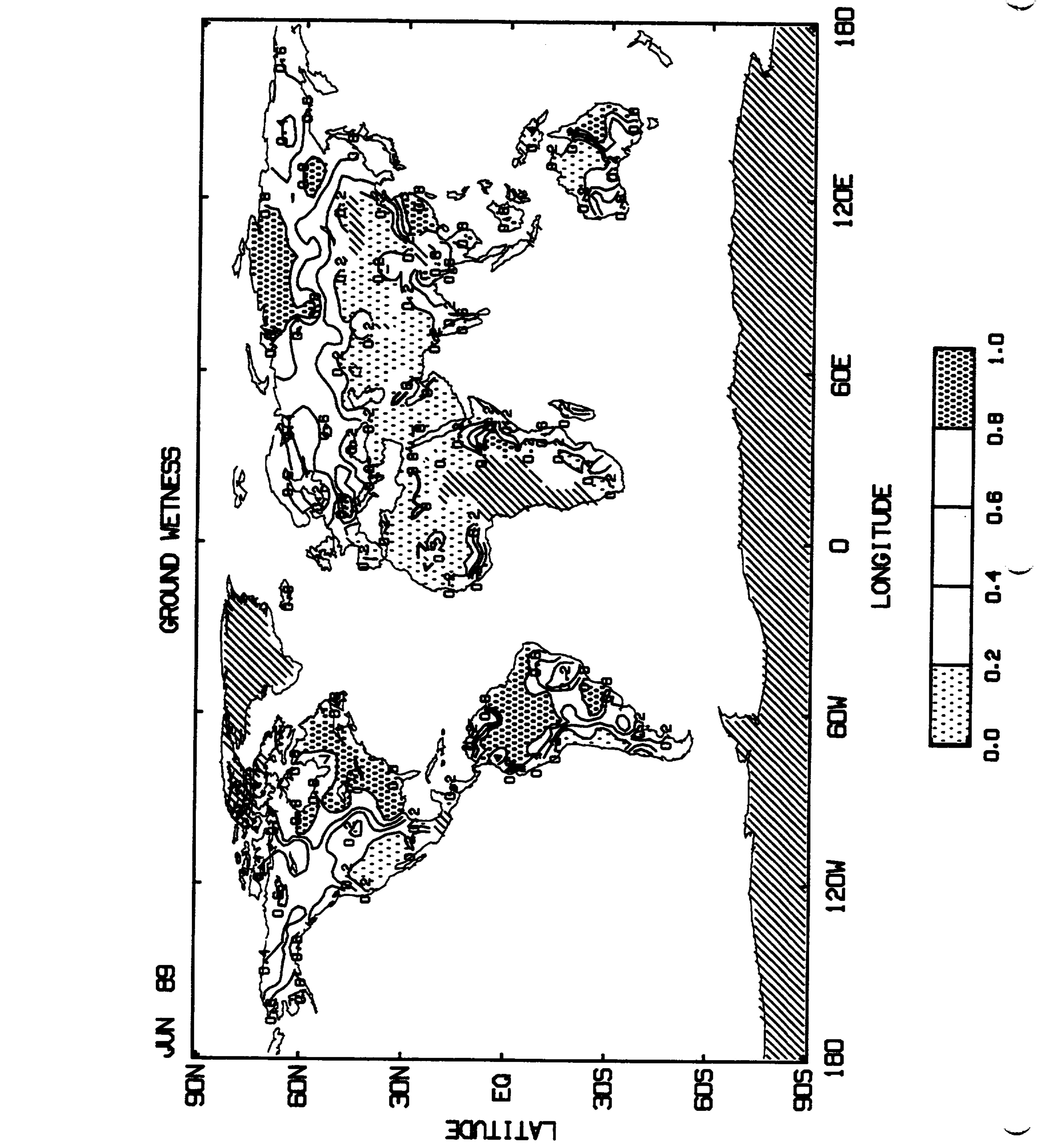
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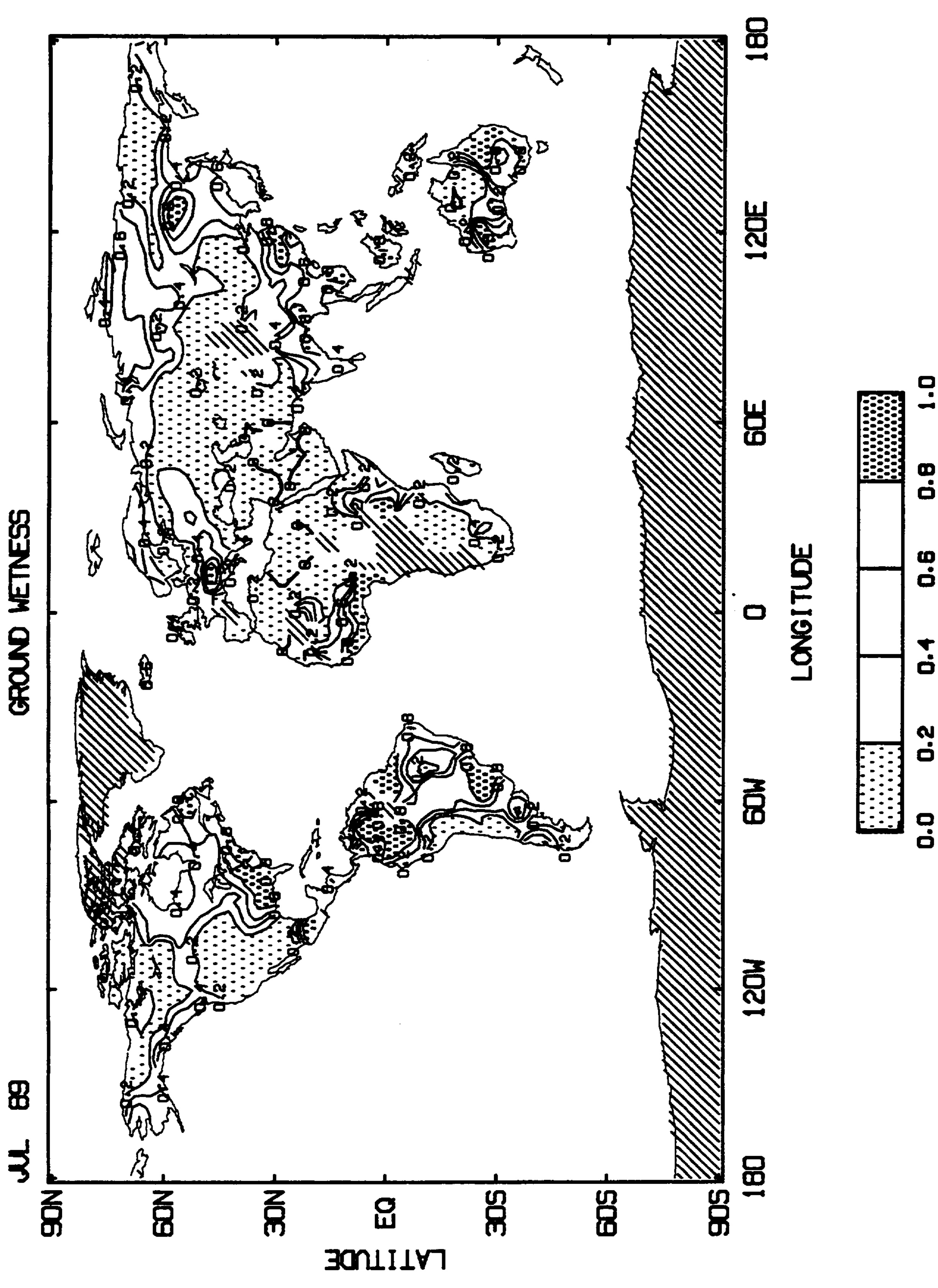
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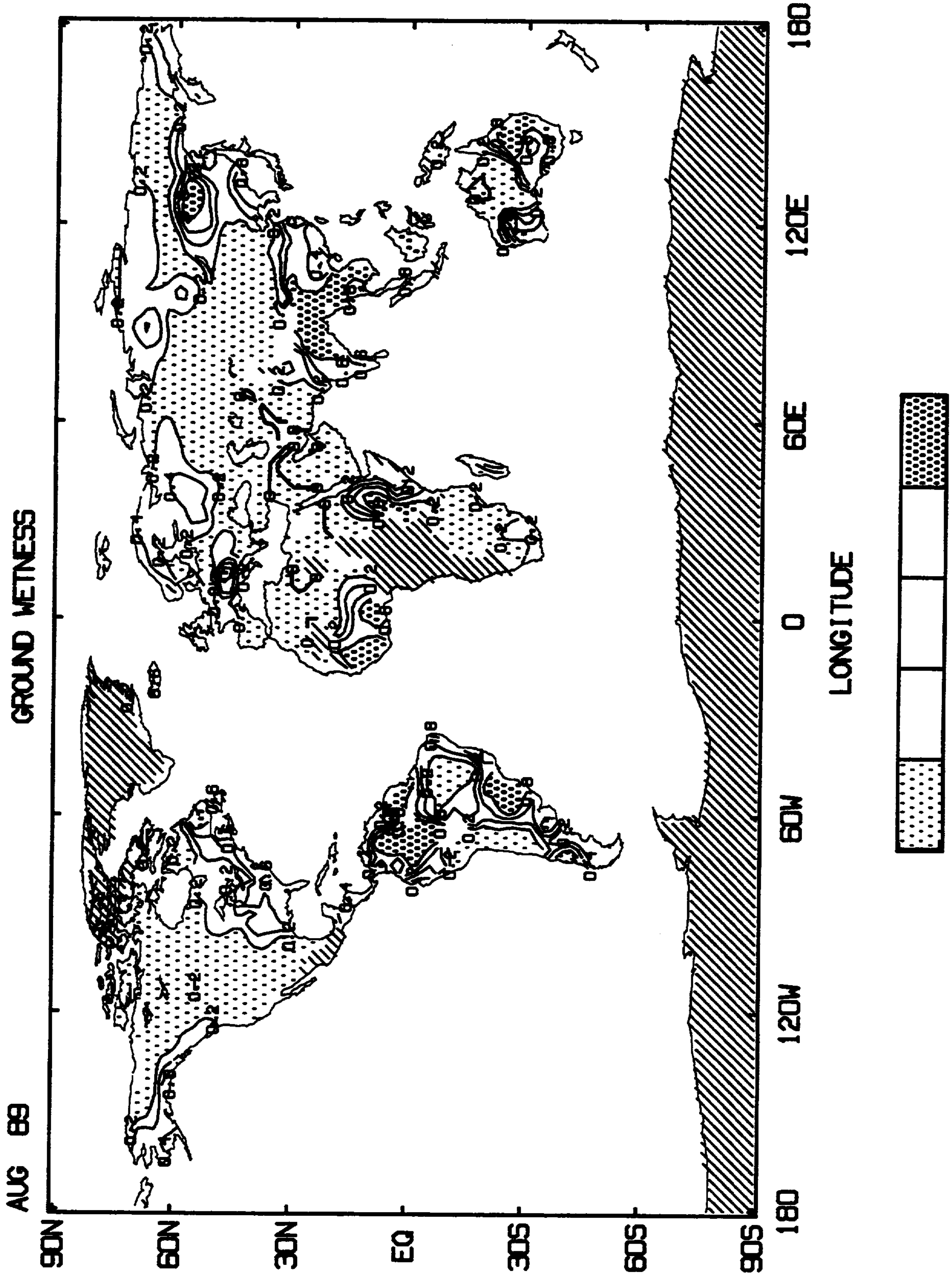

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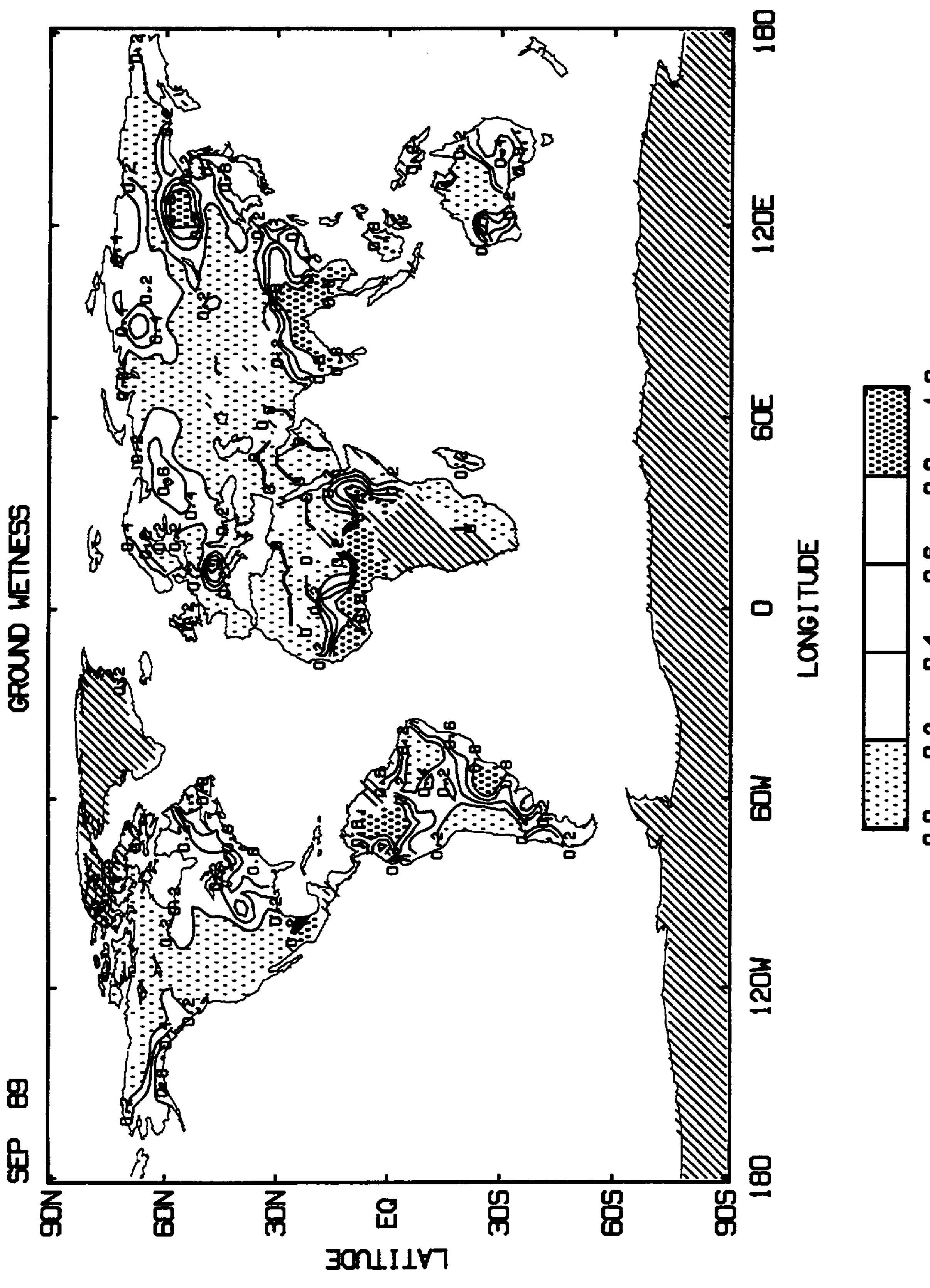
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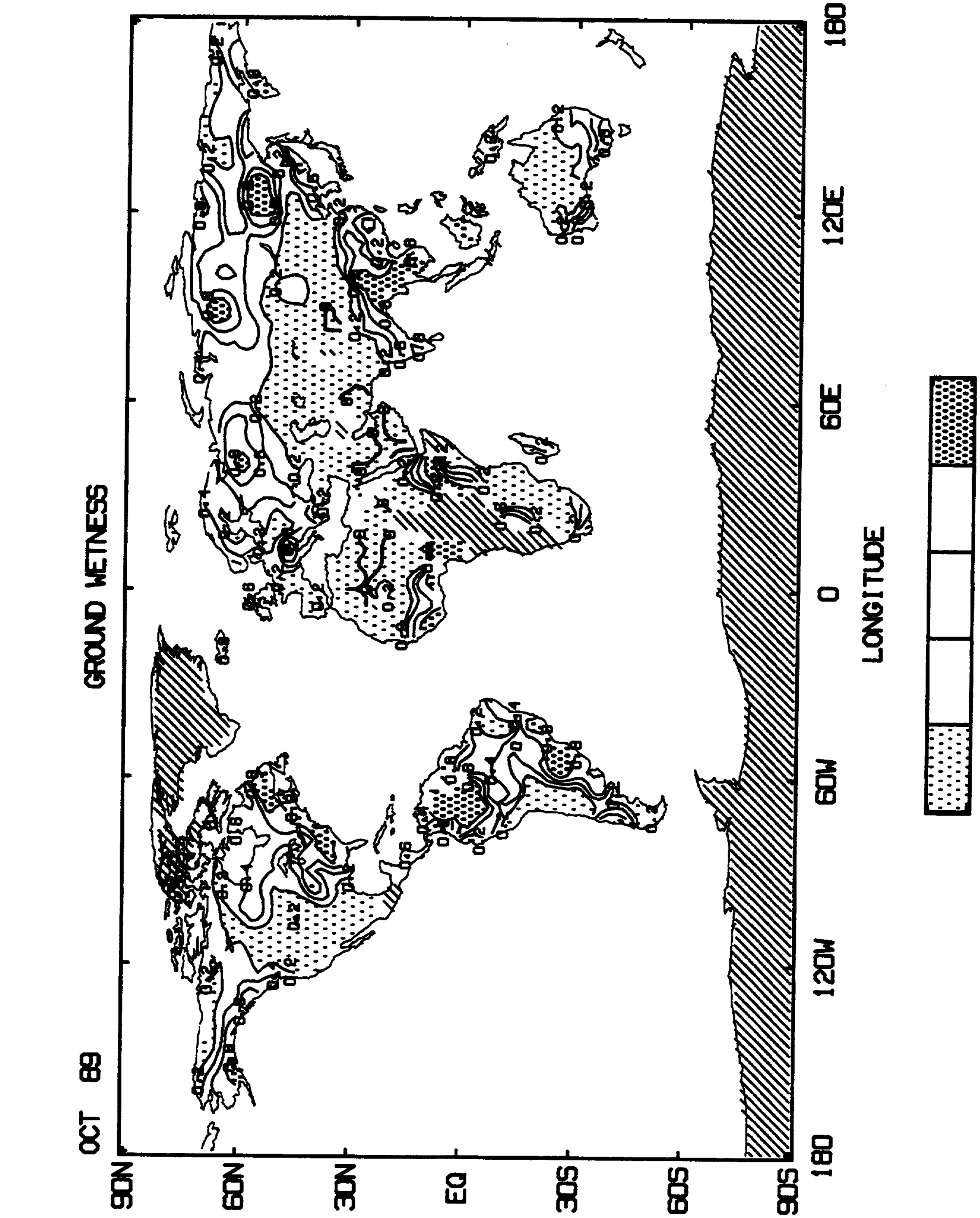
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GROUND WETNESS
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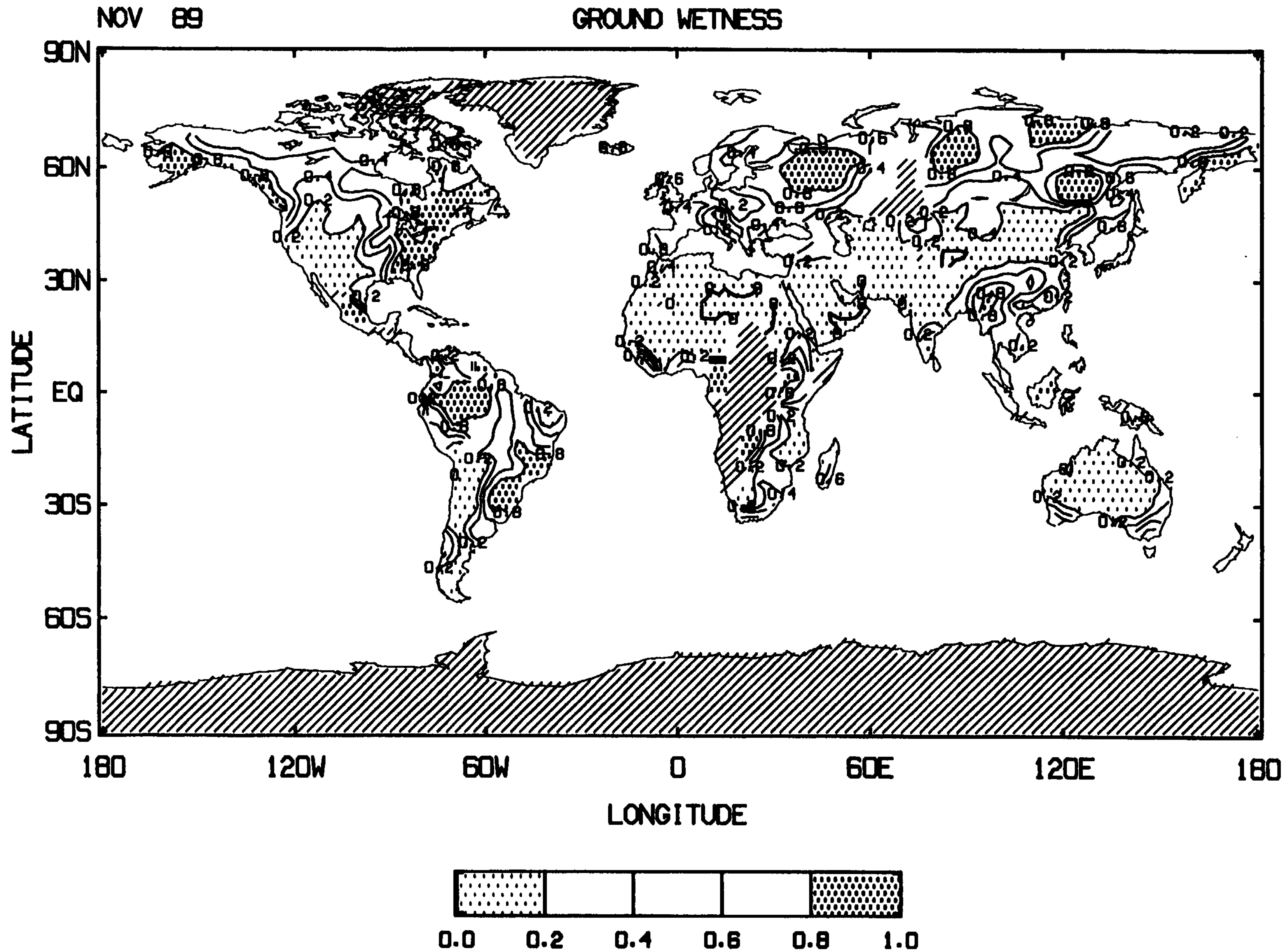
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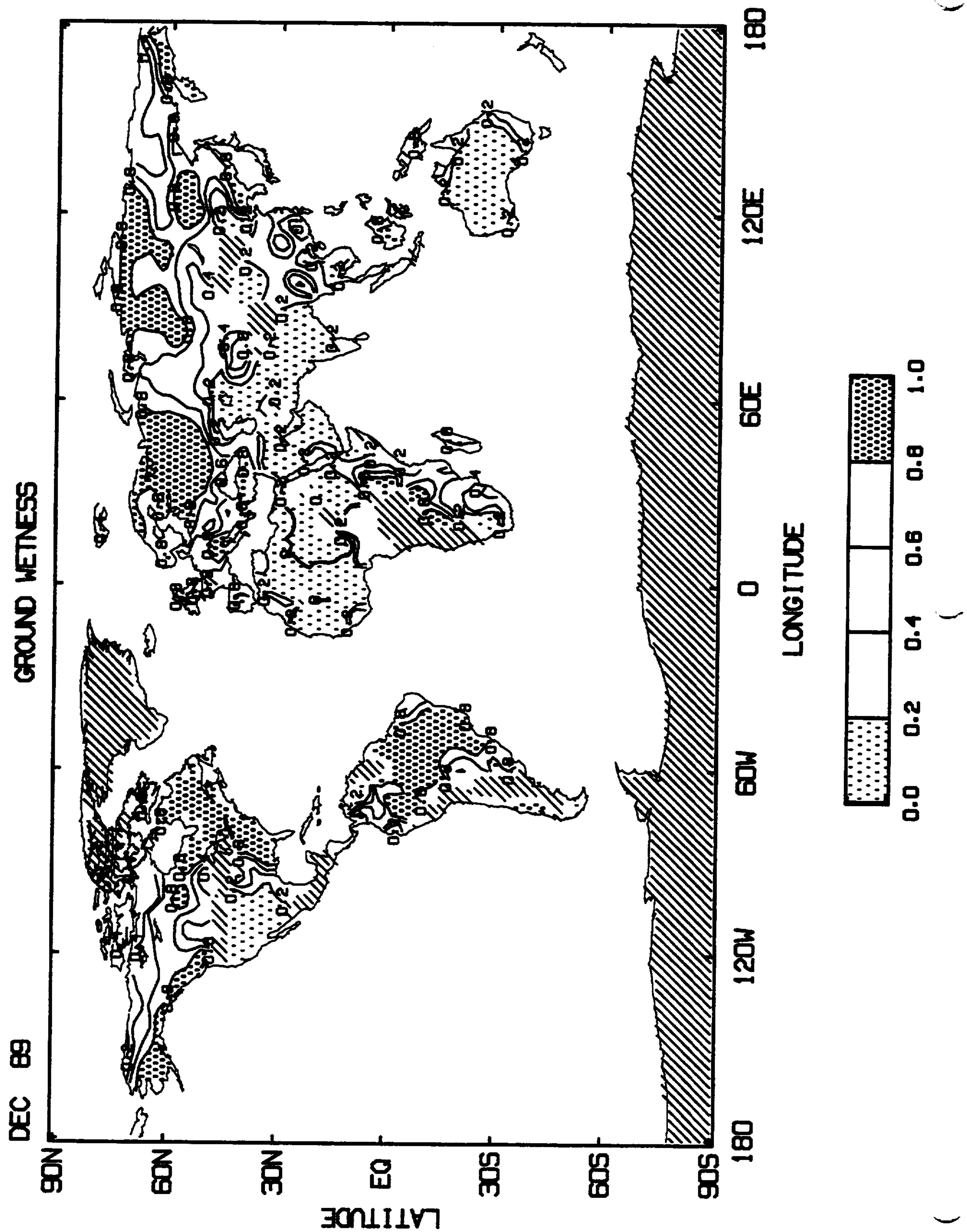
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11 YEAR AVERAGE

JANUARY

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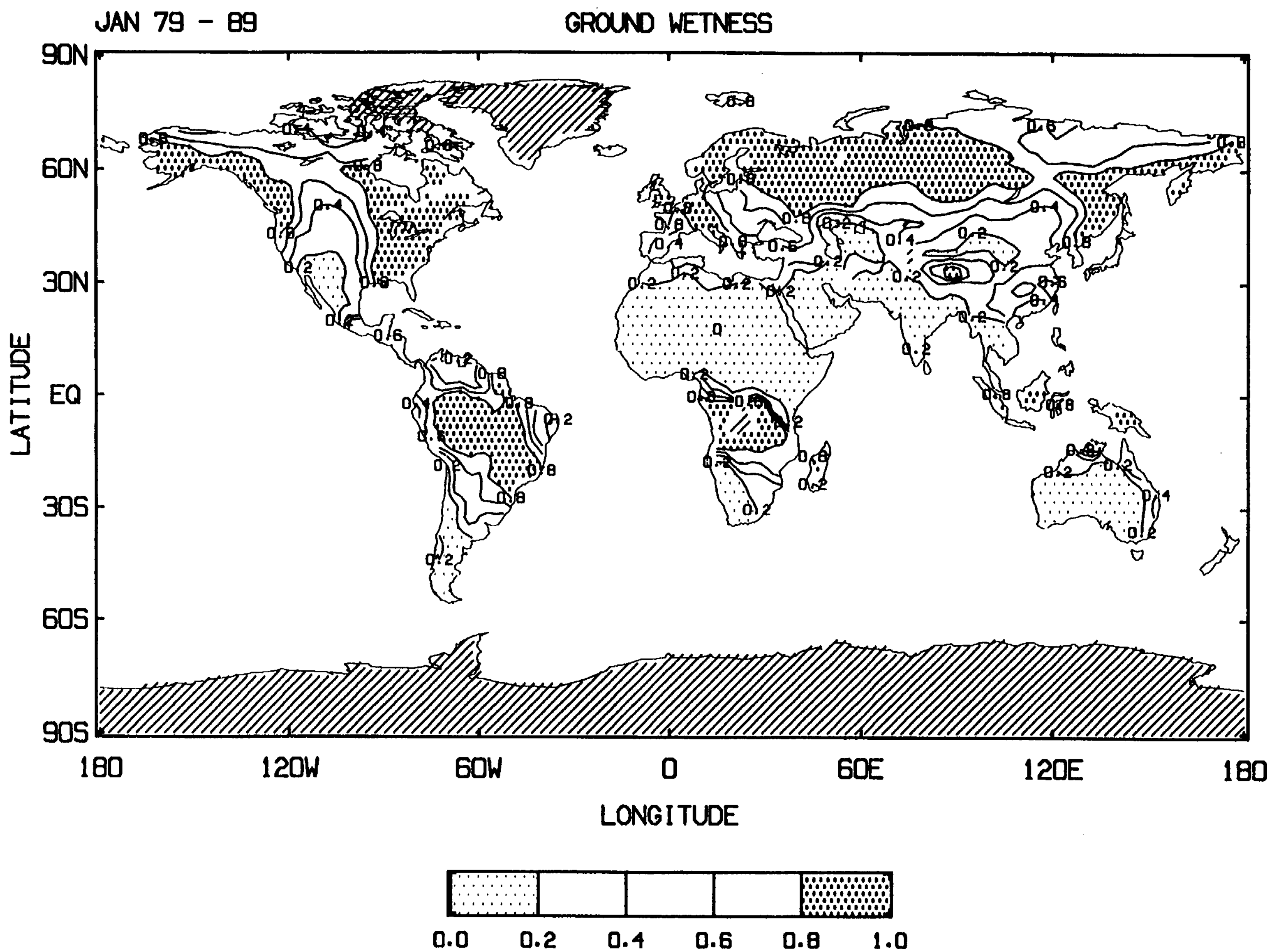
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GROUND WETNESS
LATITUDE
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EQ
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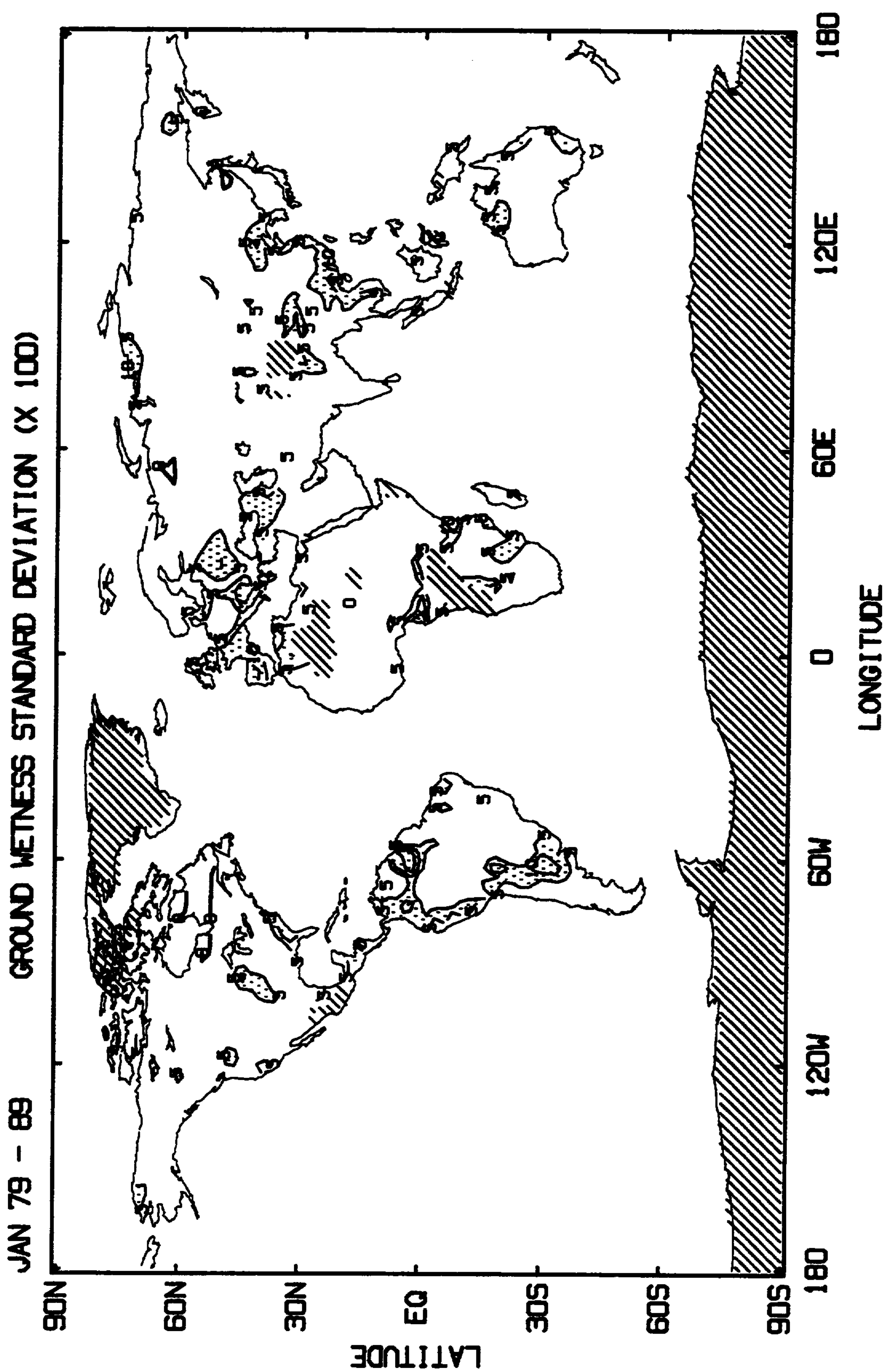
JAN 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
LATITUDE
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EQ
30S
60S
90S
LONGITUDE
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120W
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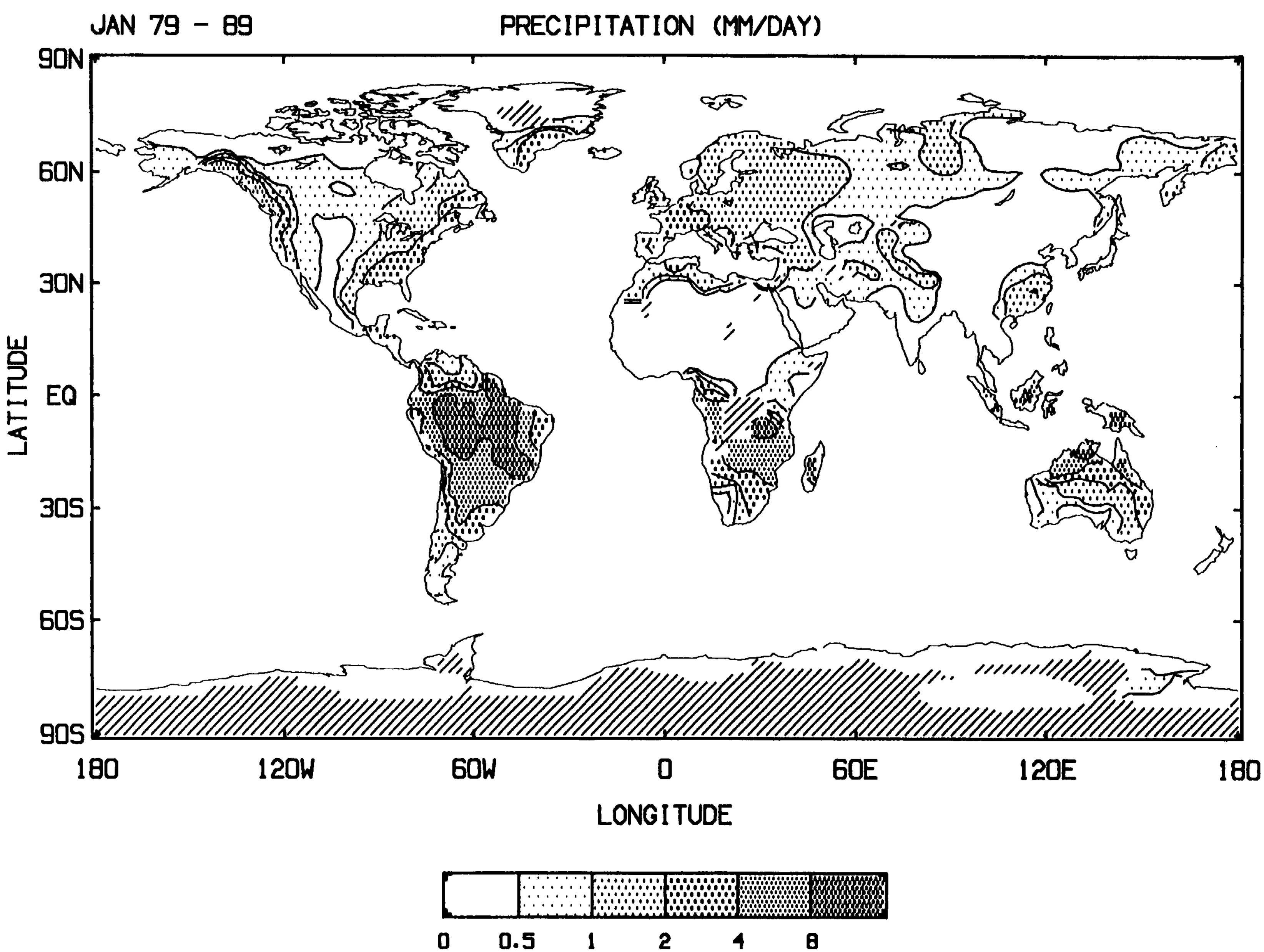
60E
120E
180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PRECIPITATION (MM/DAY)
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LONGITUDE
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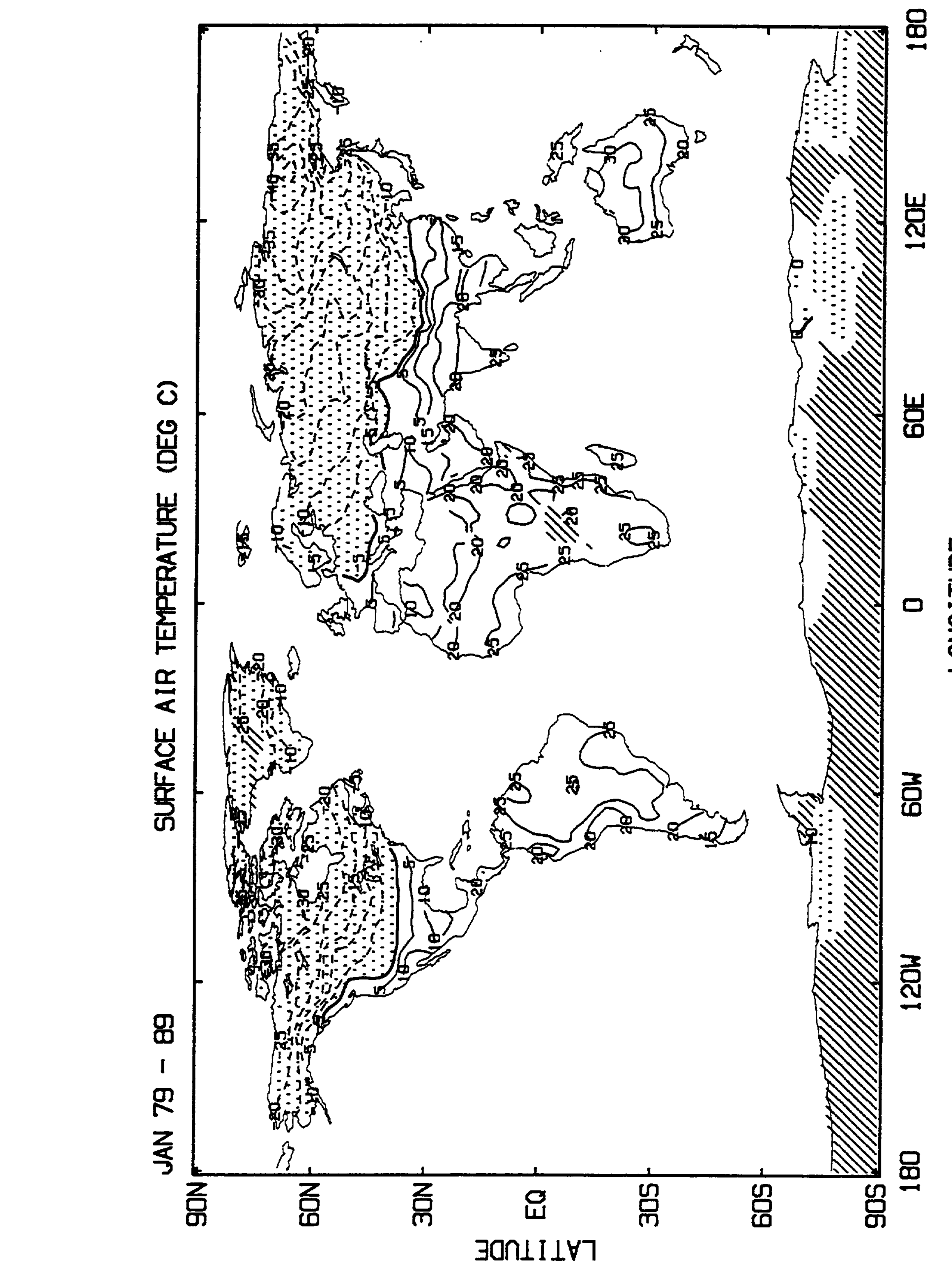
2
4
8


JAN 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
LATITUDE
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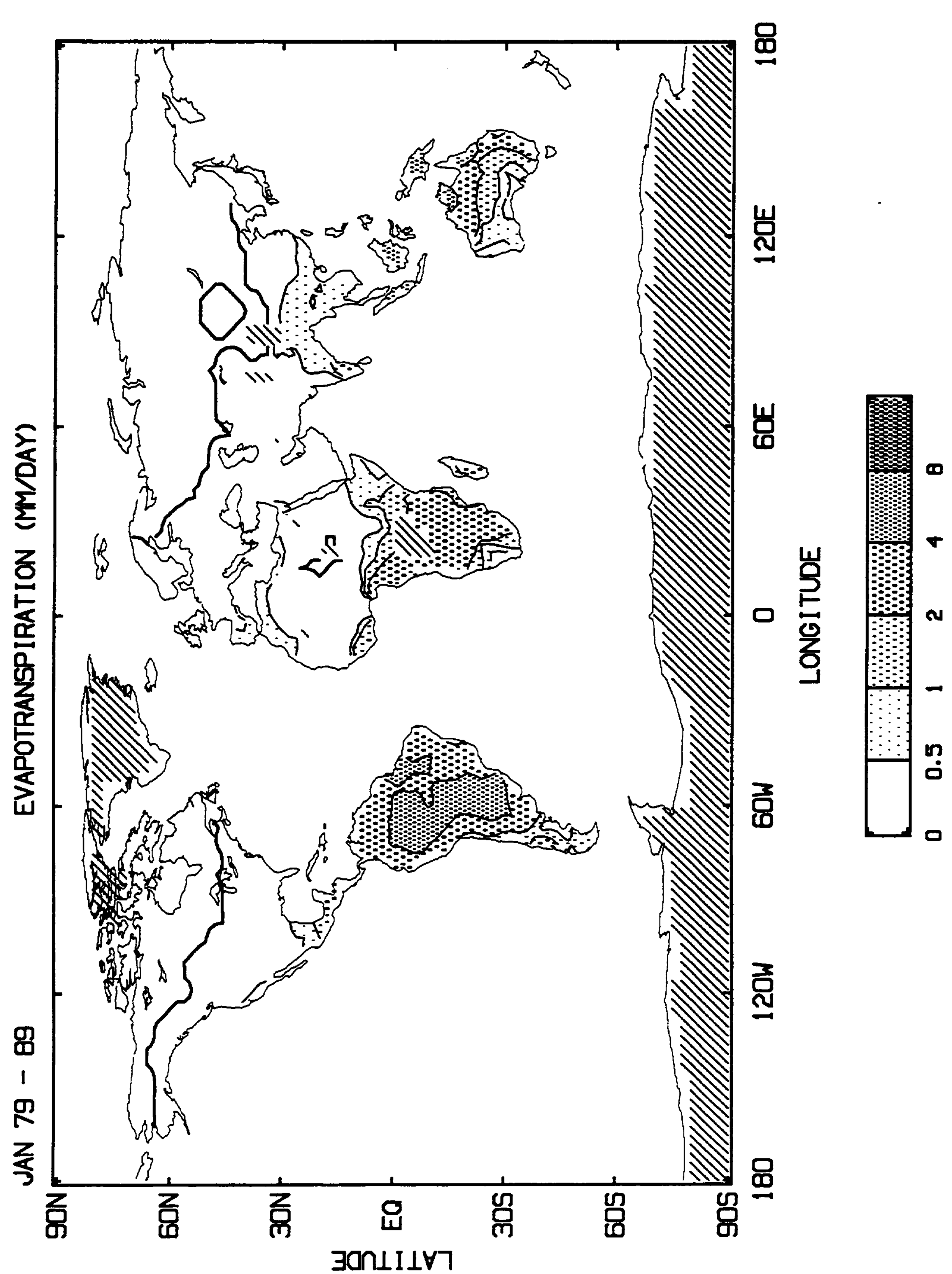
LONGITUDE


JAN 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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60N
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EQ
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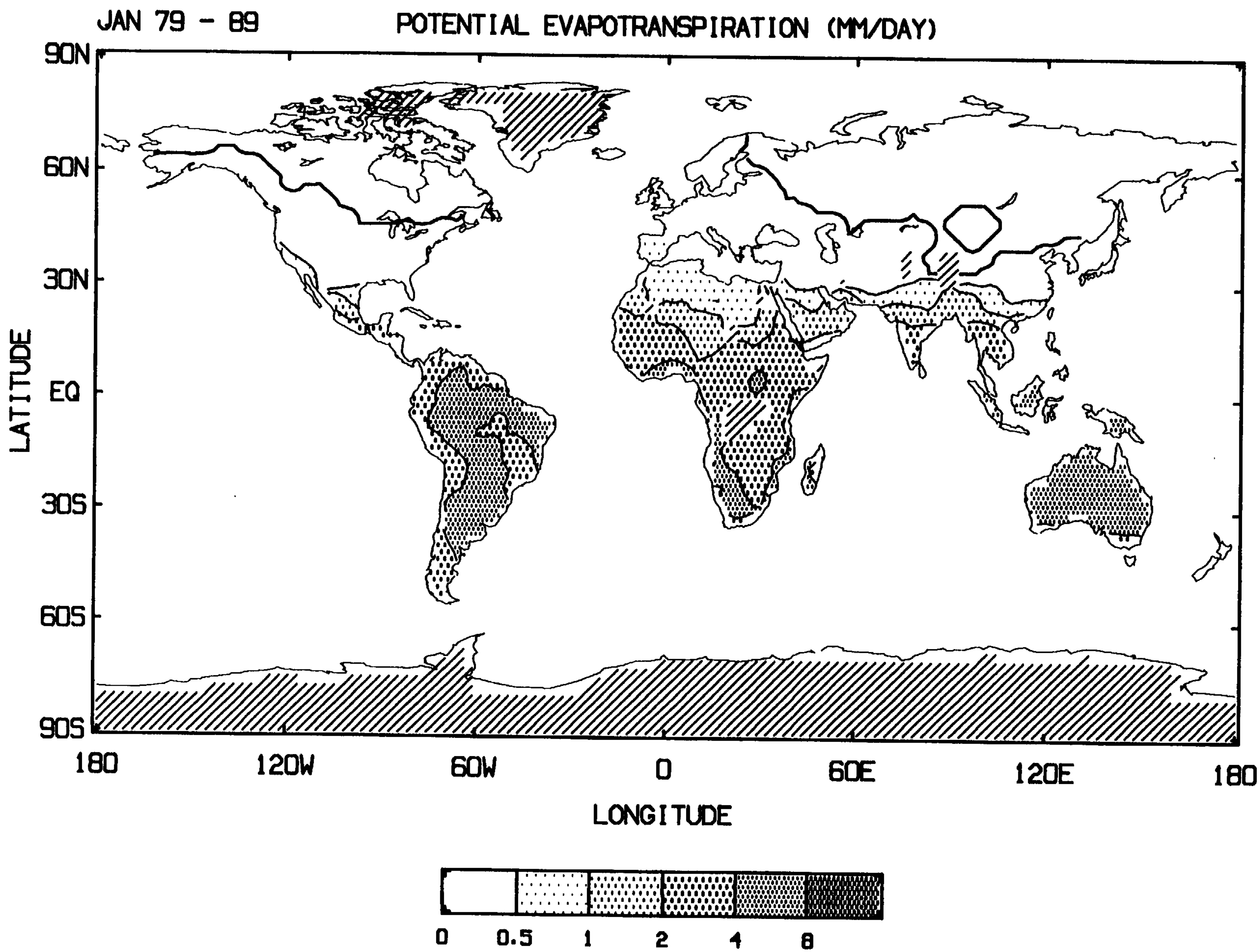
JAN 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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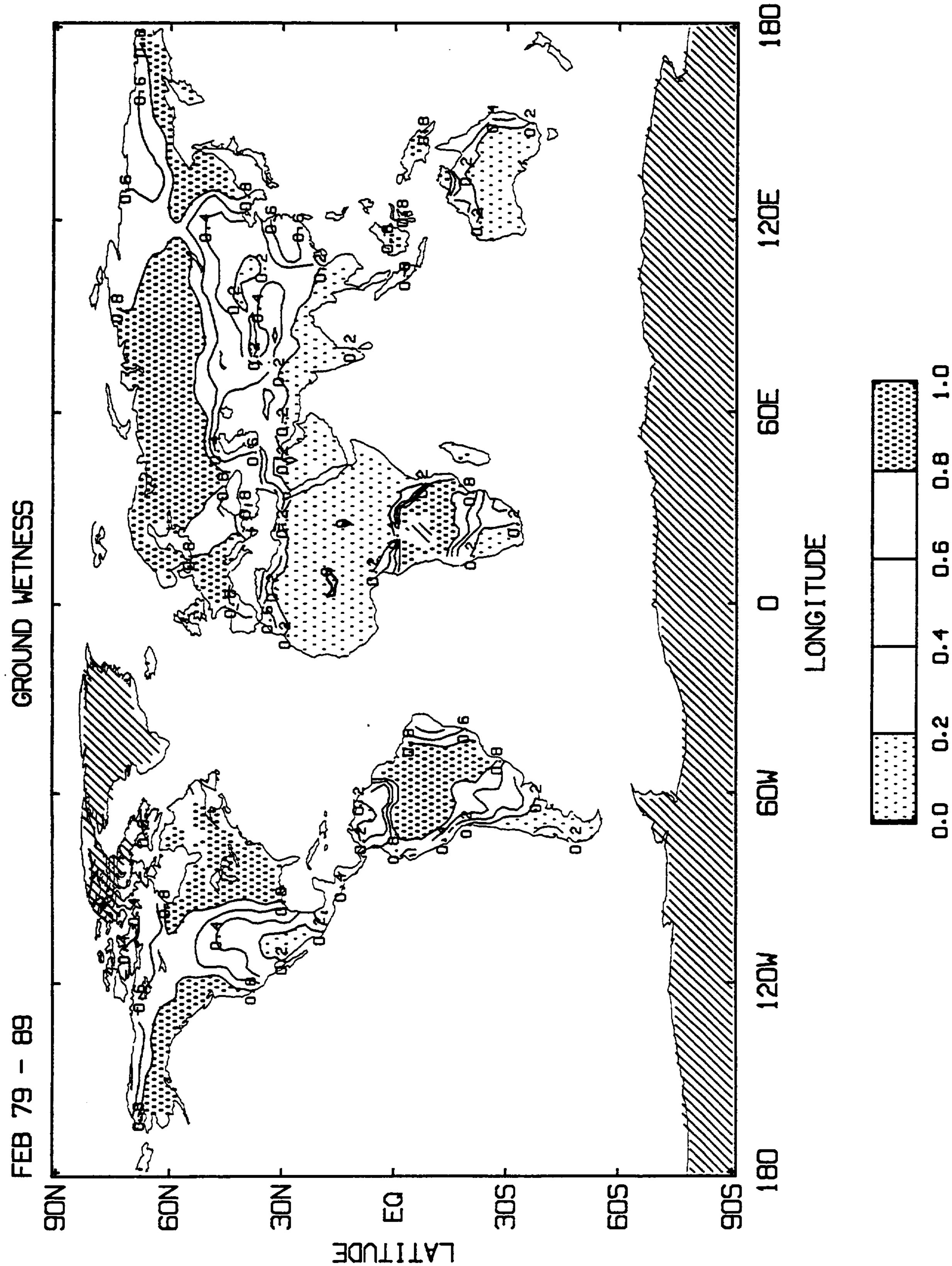
FEBRUARY


FEB 79 - 89
GROUND WETNESS
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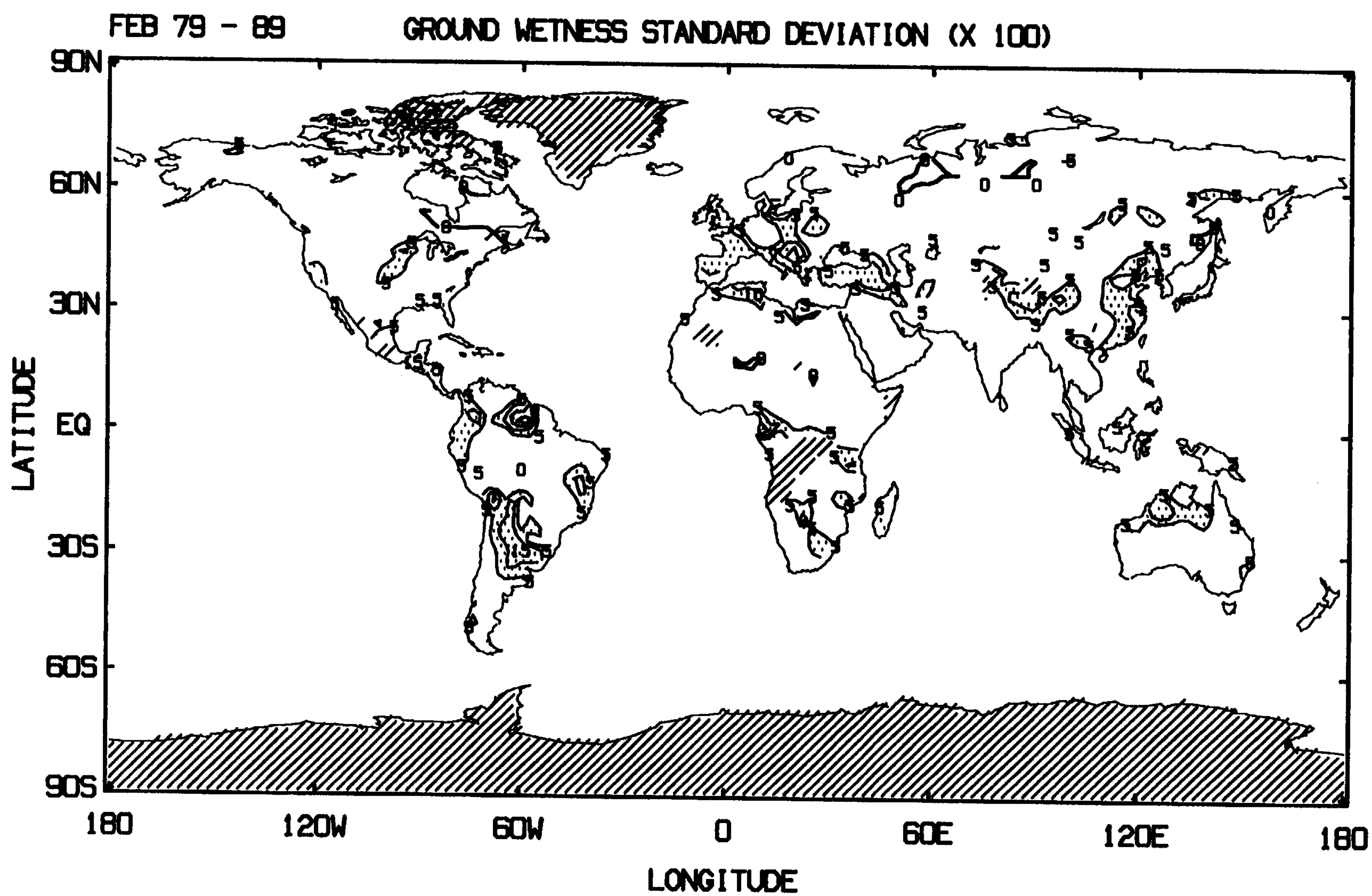
FEB 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
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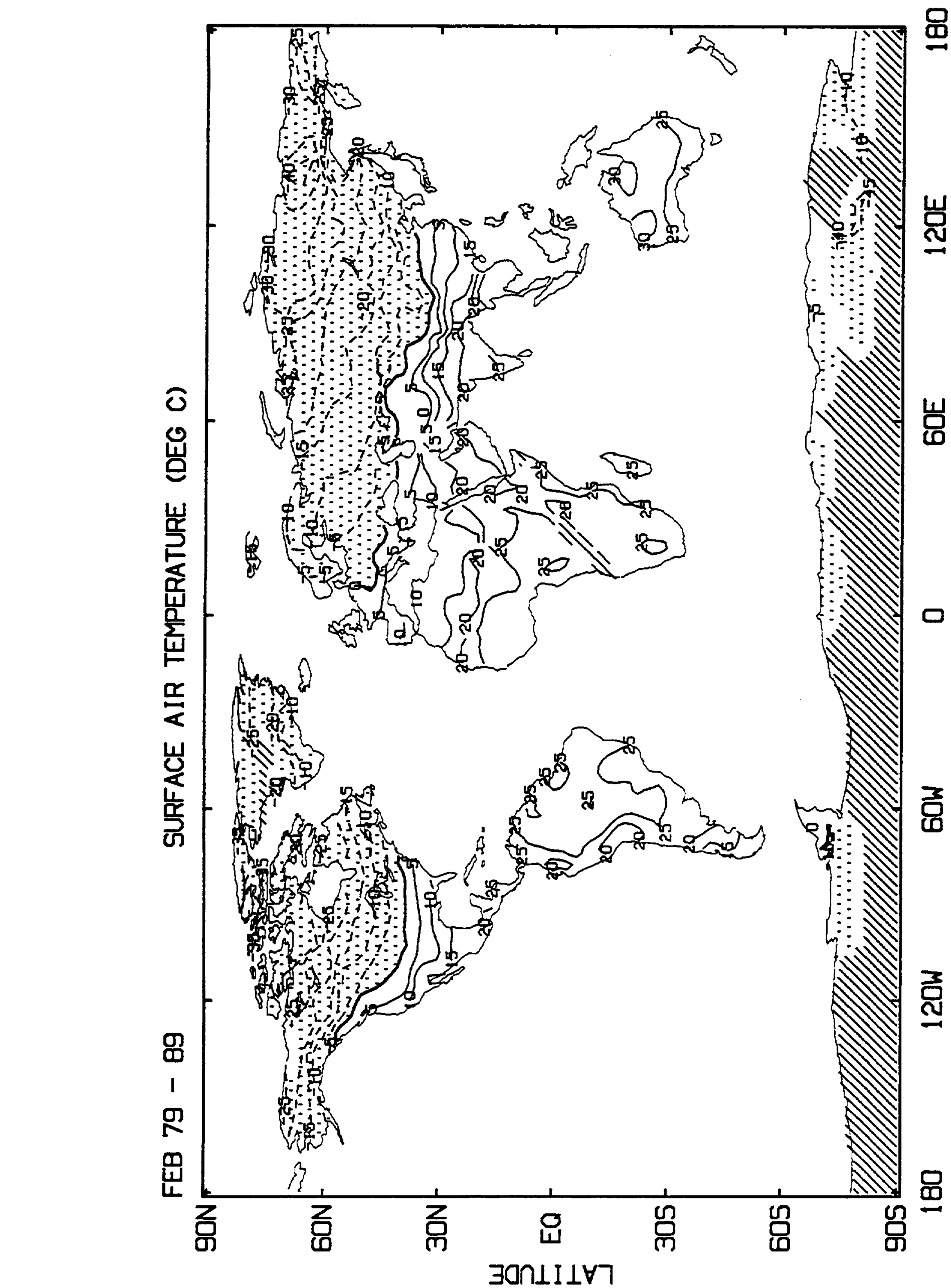
LONGITUDE


FEB 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
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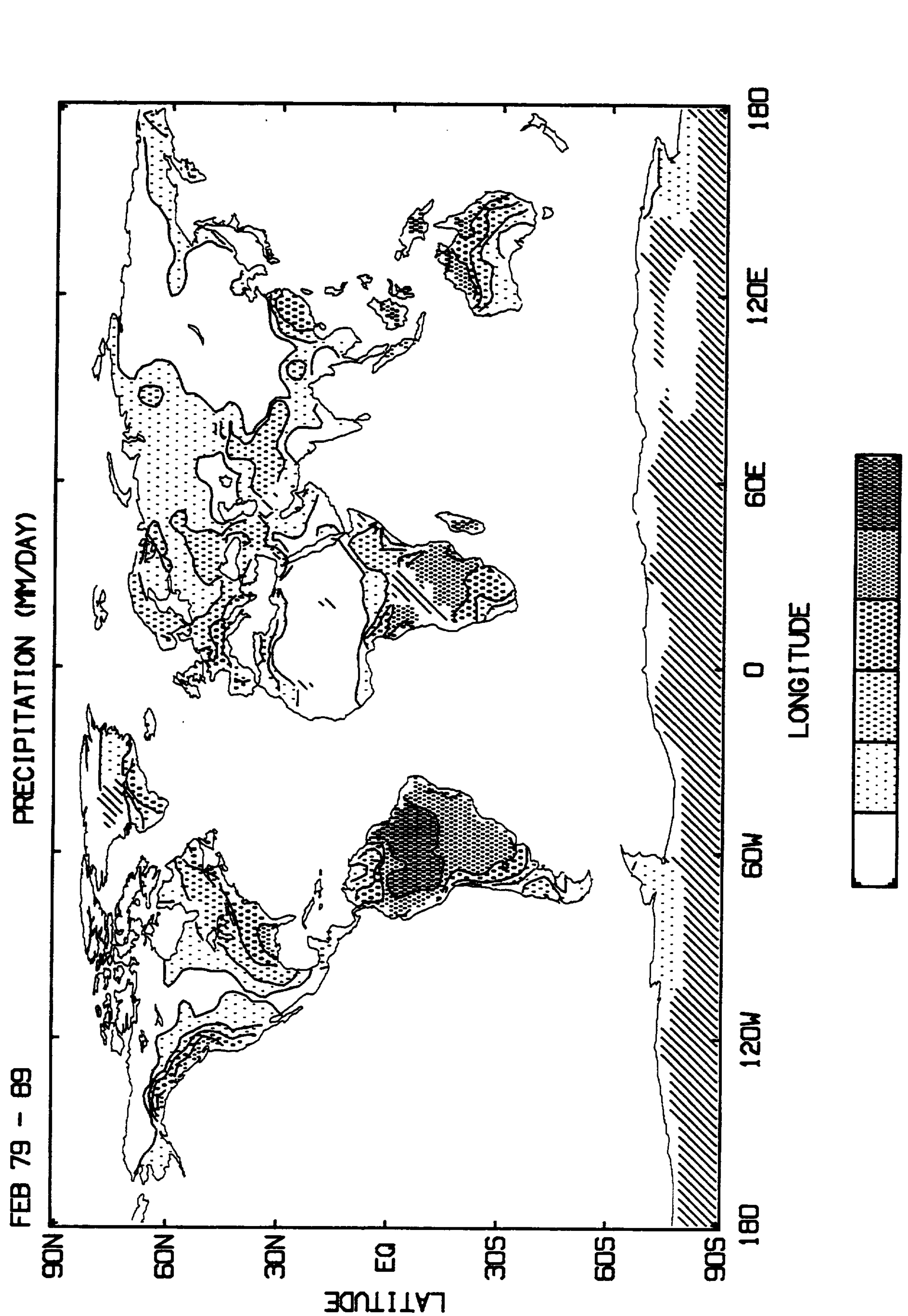
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PRECIPITATION (MM/DAY)
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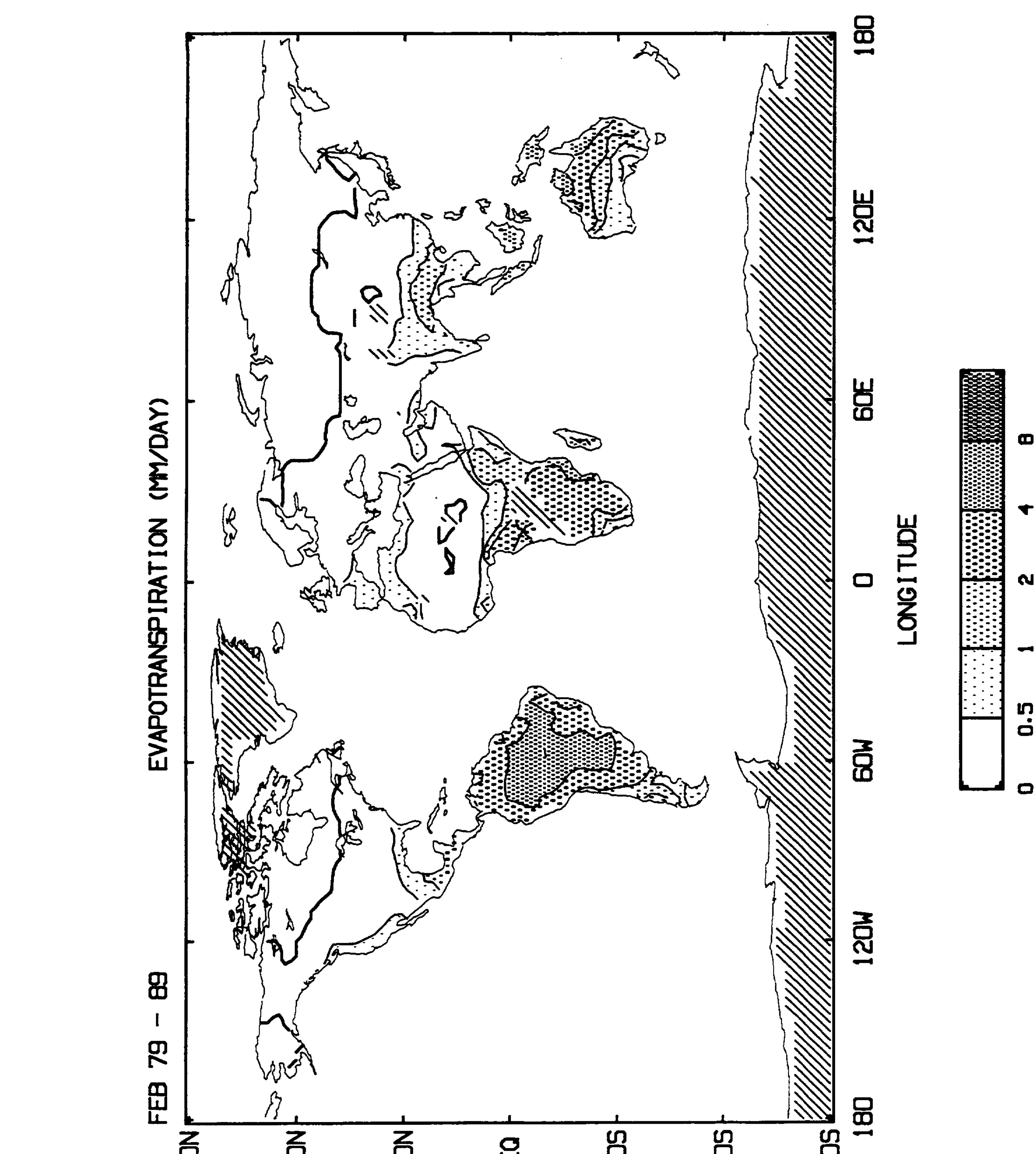
FEB 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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EQ
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90S
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LONGITUDE
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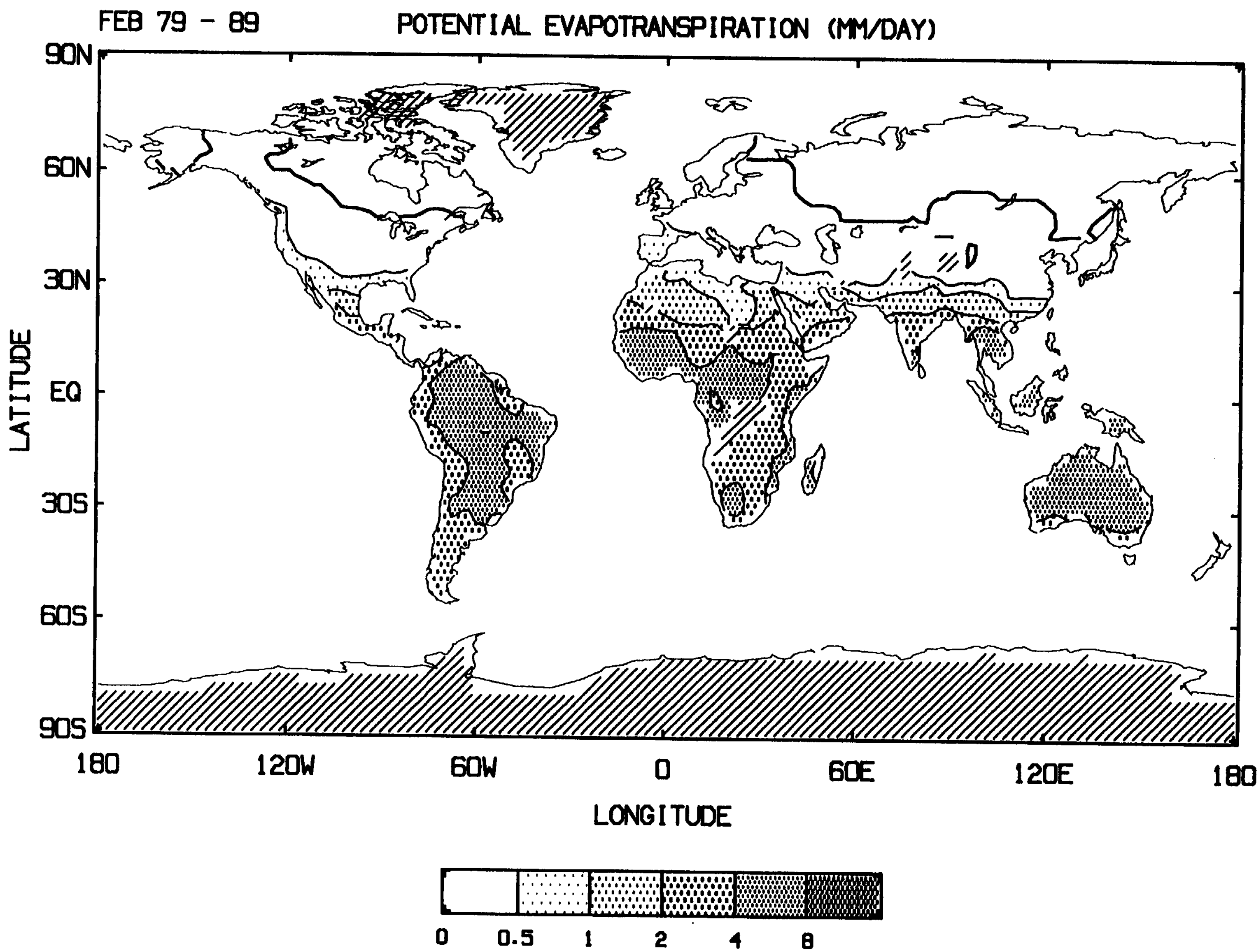
FEB 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
90N
60N
30N
EQ
30S
60S
90S
LATITUDE
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120W
60W
0
60E
120E
180
LONGITUDE
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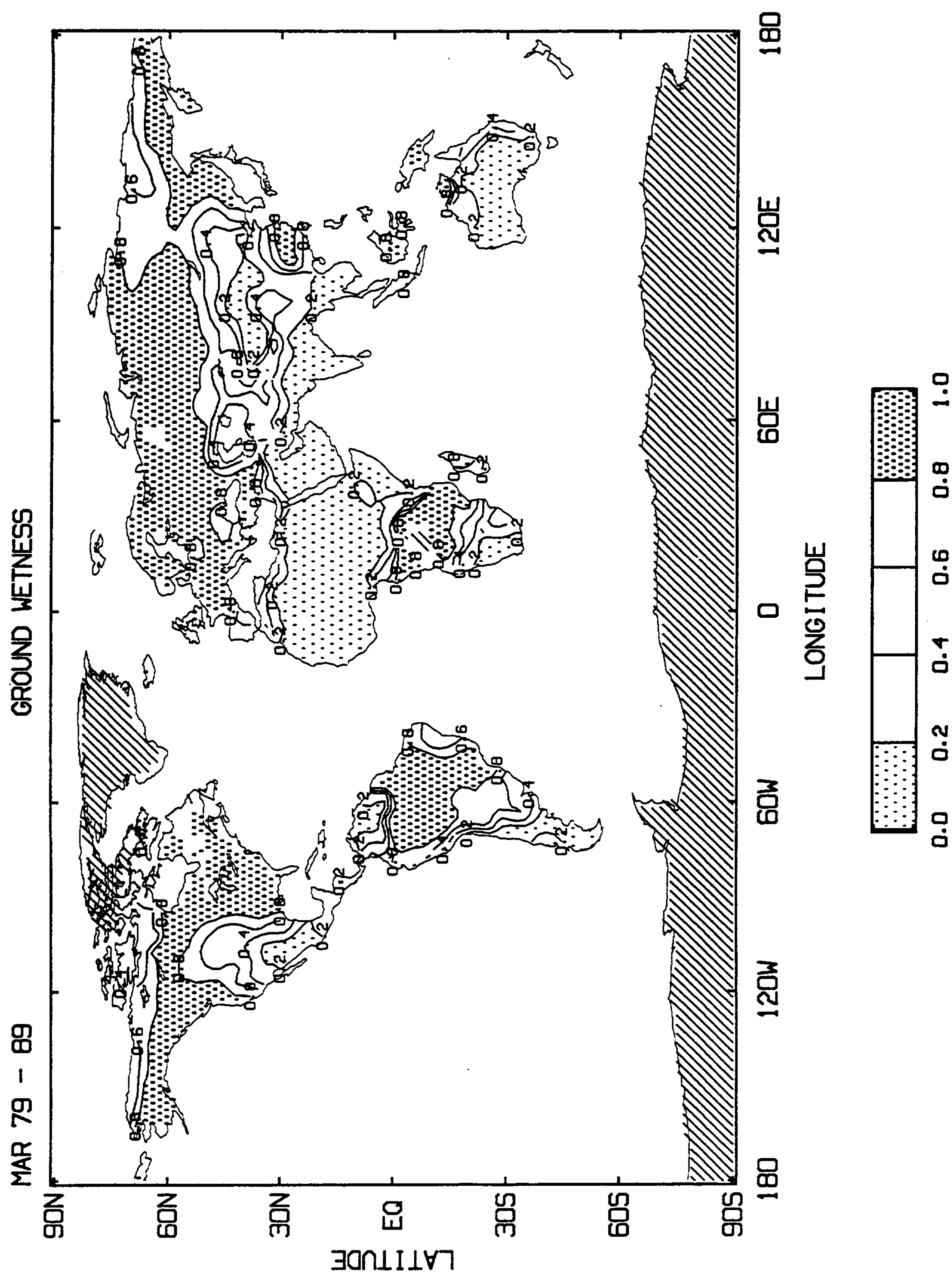
MARCH


MAR 79 - 89
GROUND WETNESS
LATITUDE
90N
60N
30N
EQ
30S
60S
90S
LONGITUDE
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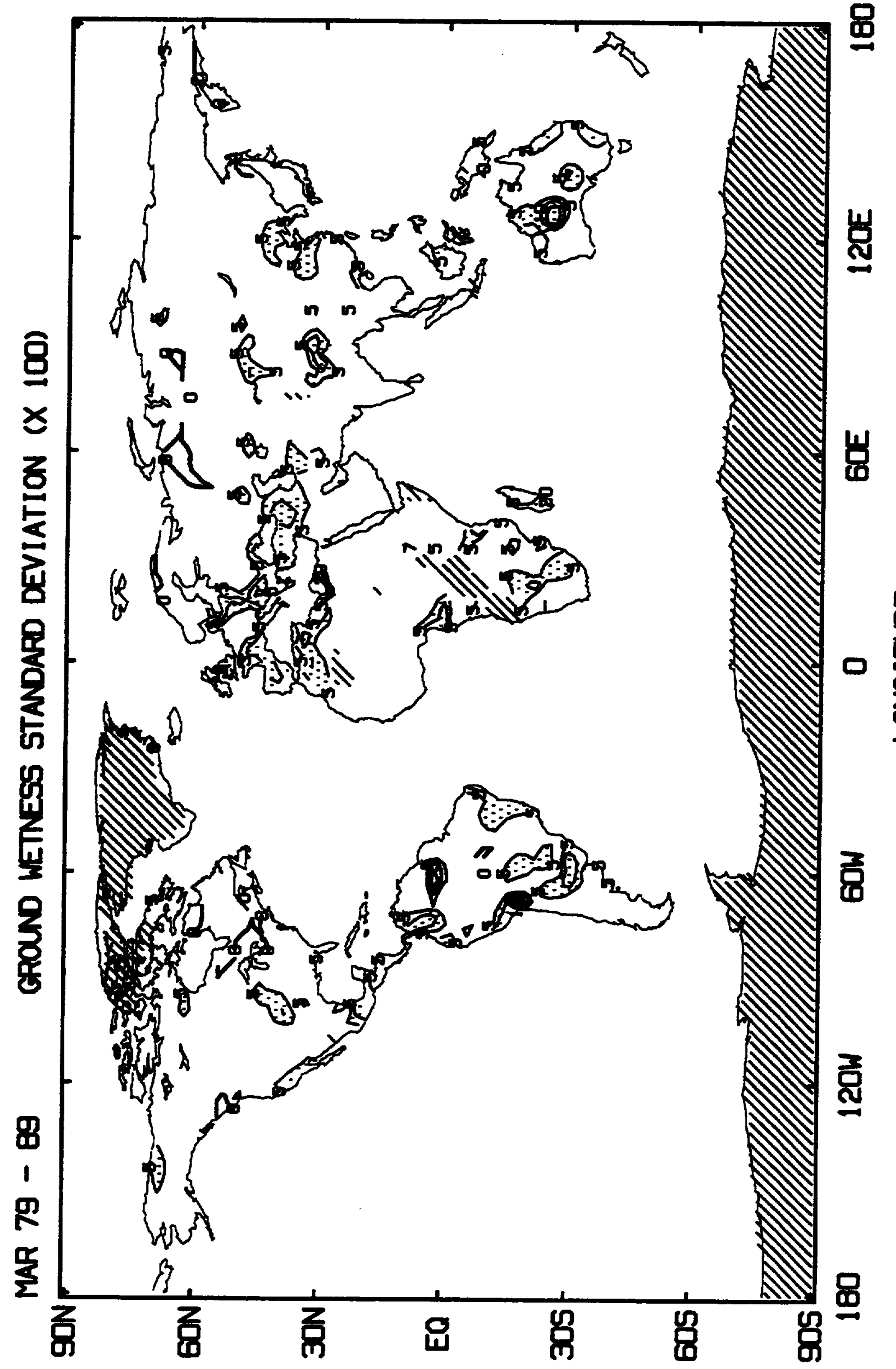
MAR 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
LATITUDE
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EQ
30S
60S
90S
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60W
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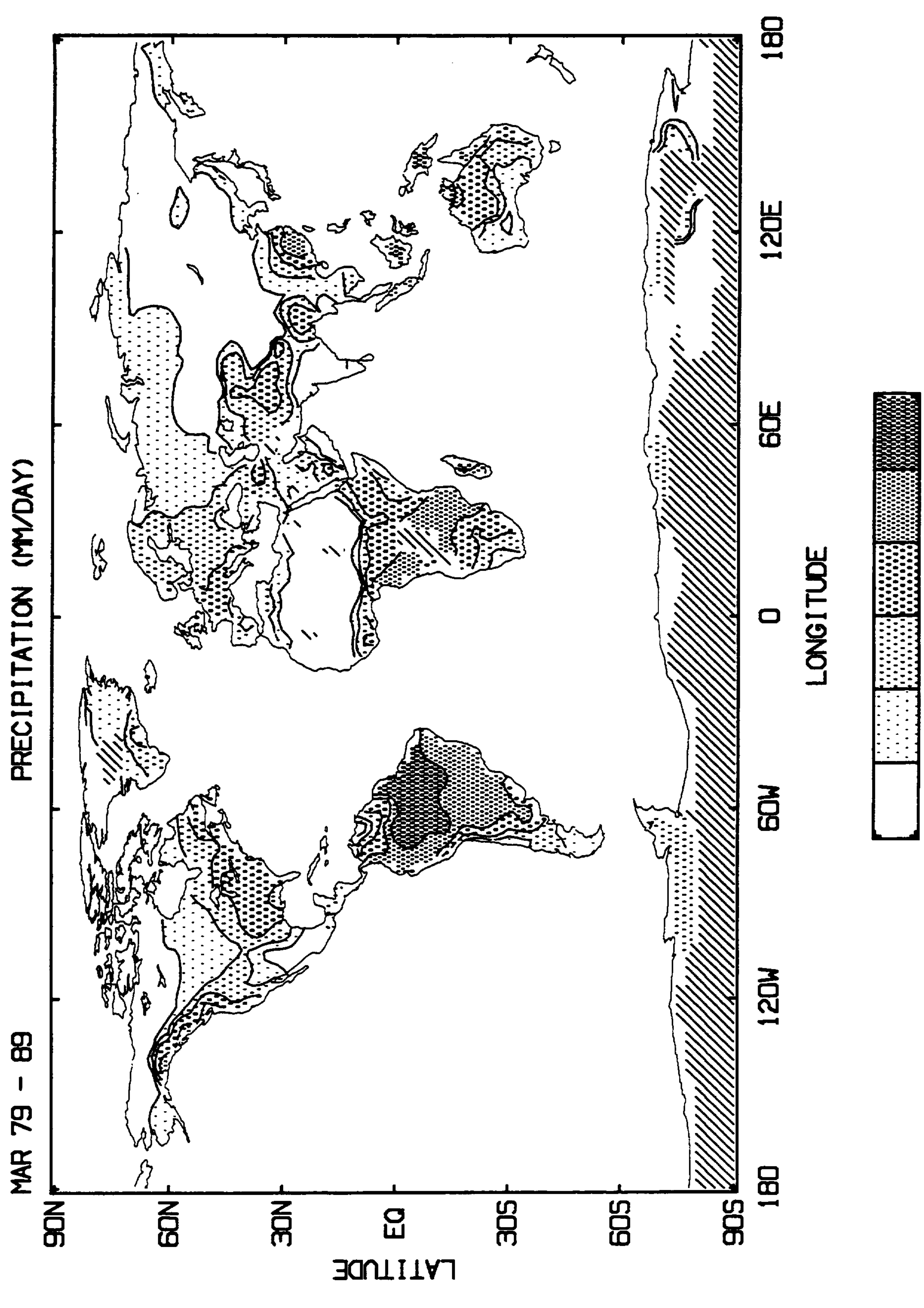
120E
180
LONGITUDE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PRECIPITATION (MM/DAY)
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EQ
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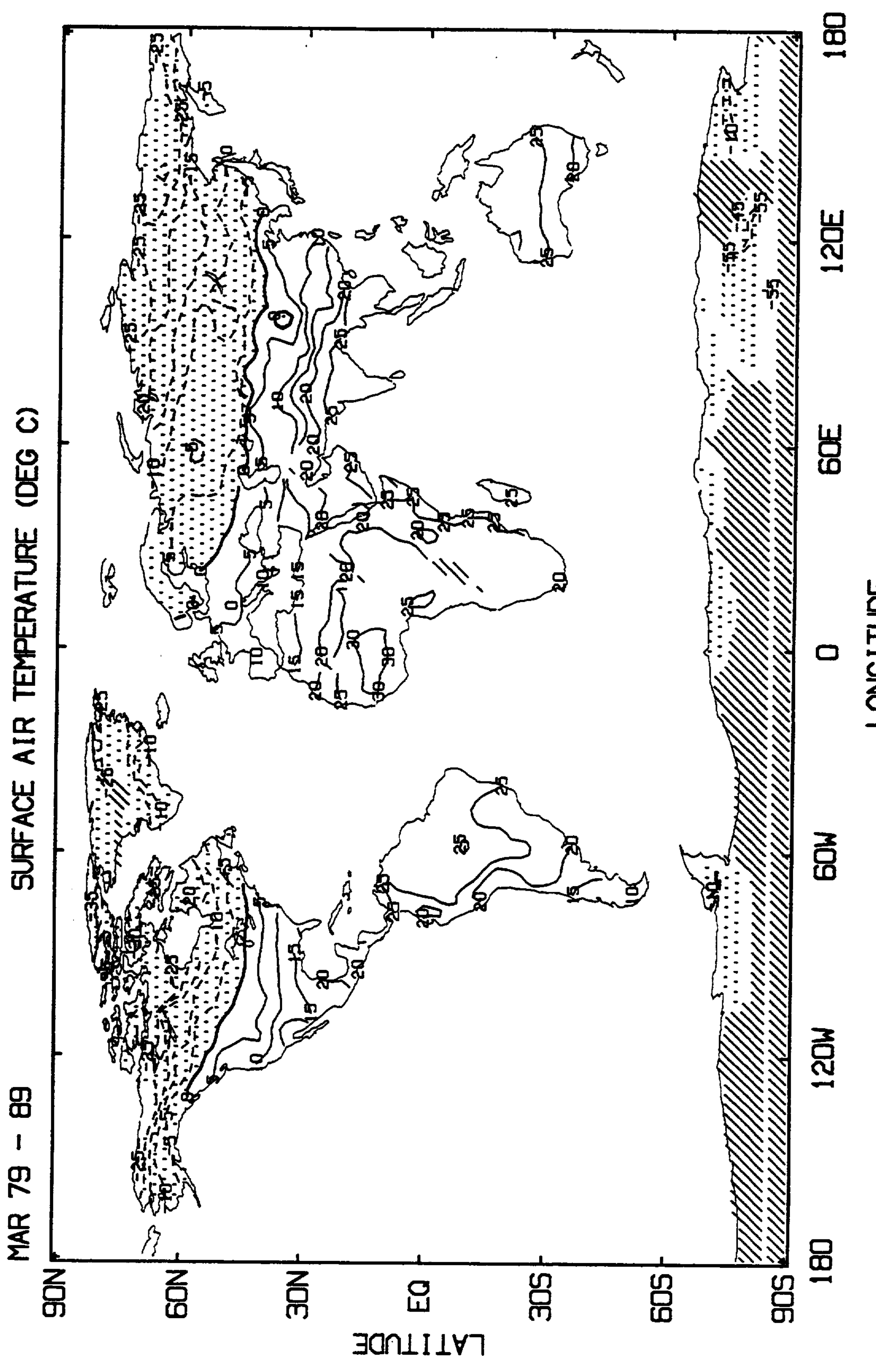
MAR 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
90N
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90S
LATITUDE
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60W
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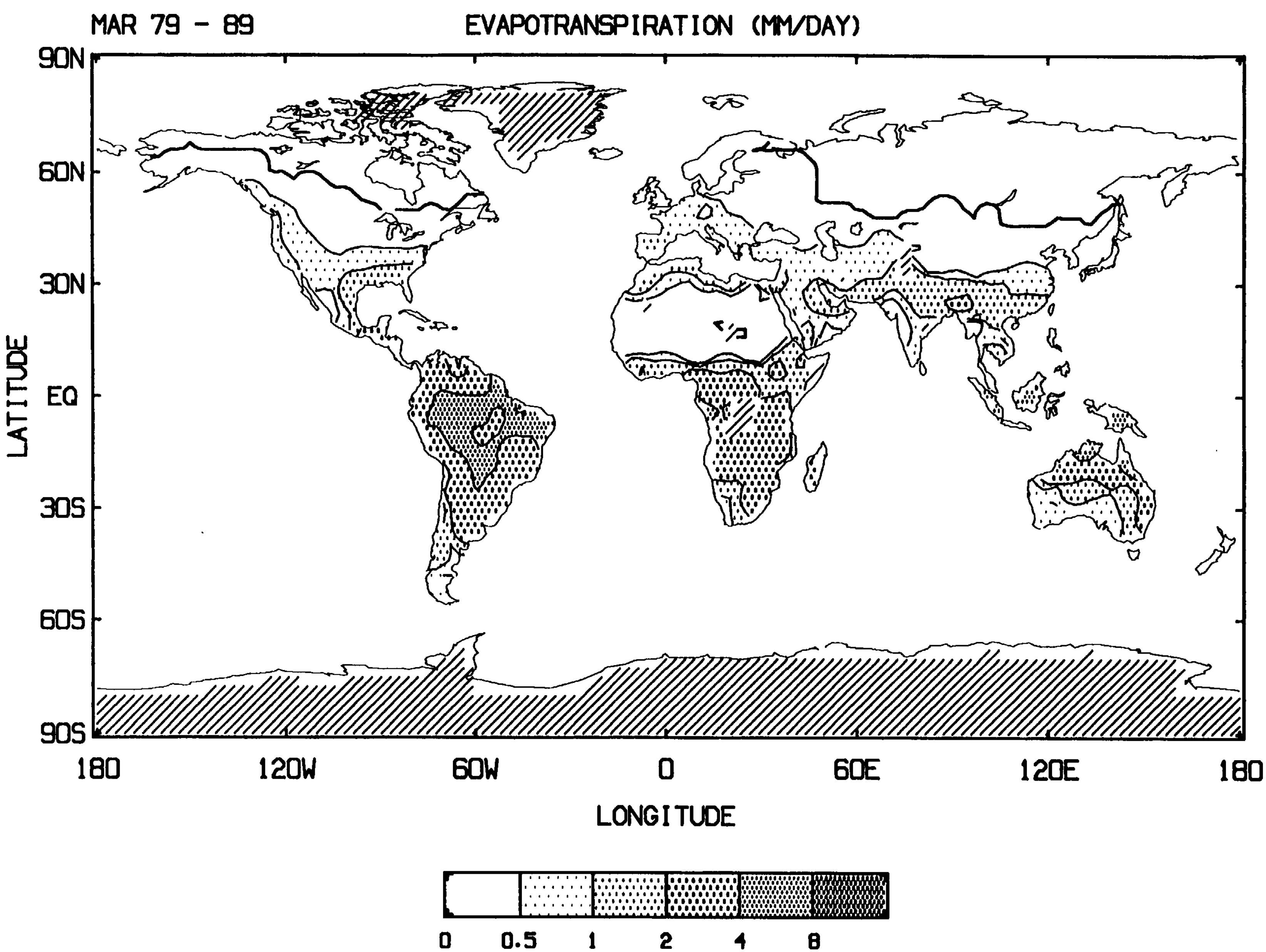
LONGITUDE


MAR 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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EQ
30S
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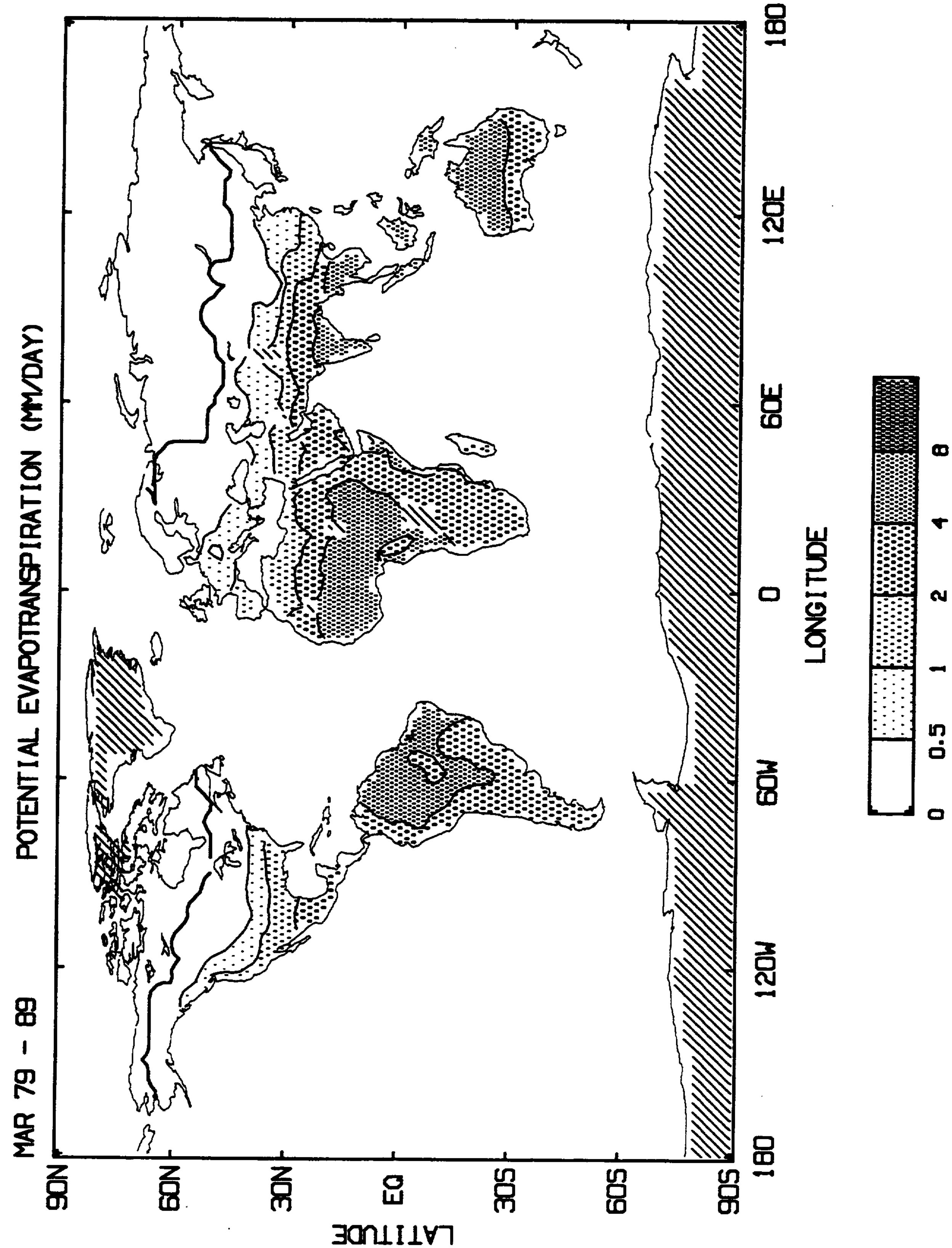
MAR 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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60N
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EQ
30S
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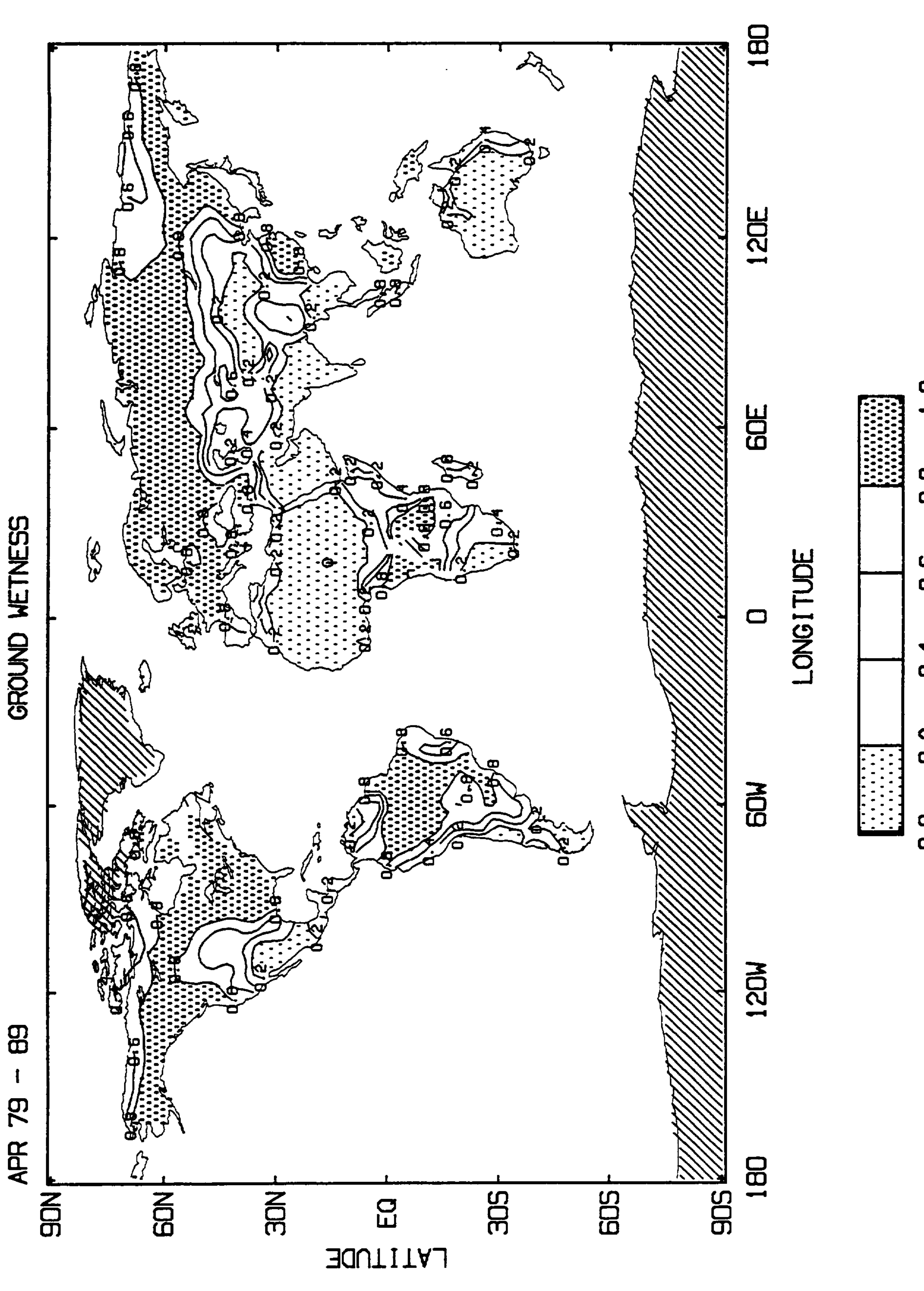
APRIL



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GROUND WETNESS
LATITUDE
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EQ
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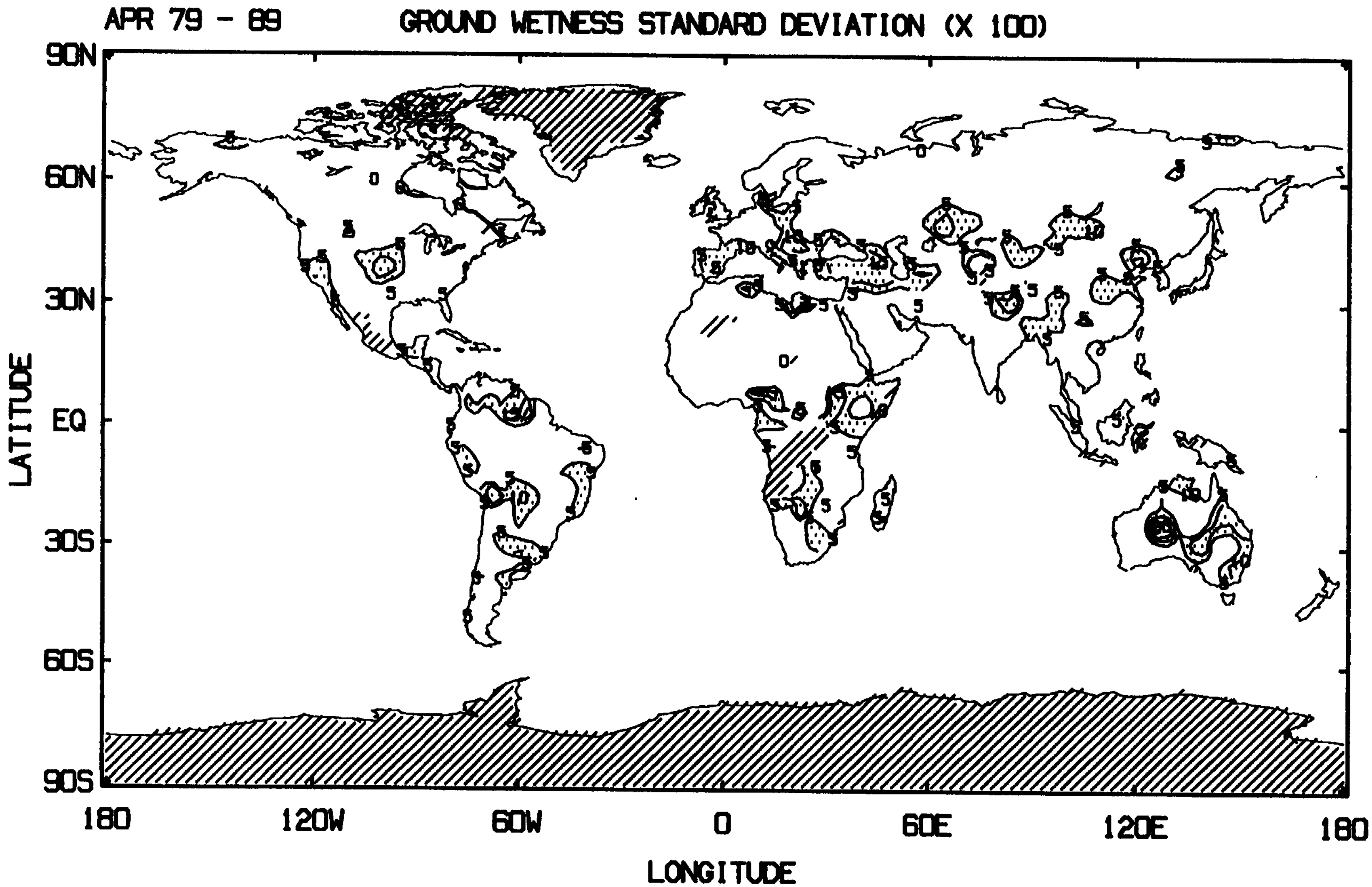
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GROUND WETNESS STANDARD DEVIATION (X 100)
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60W
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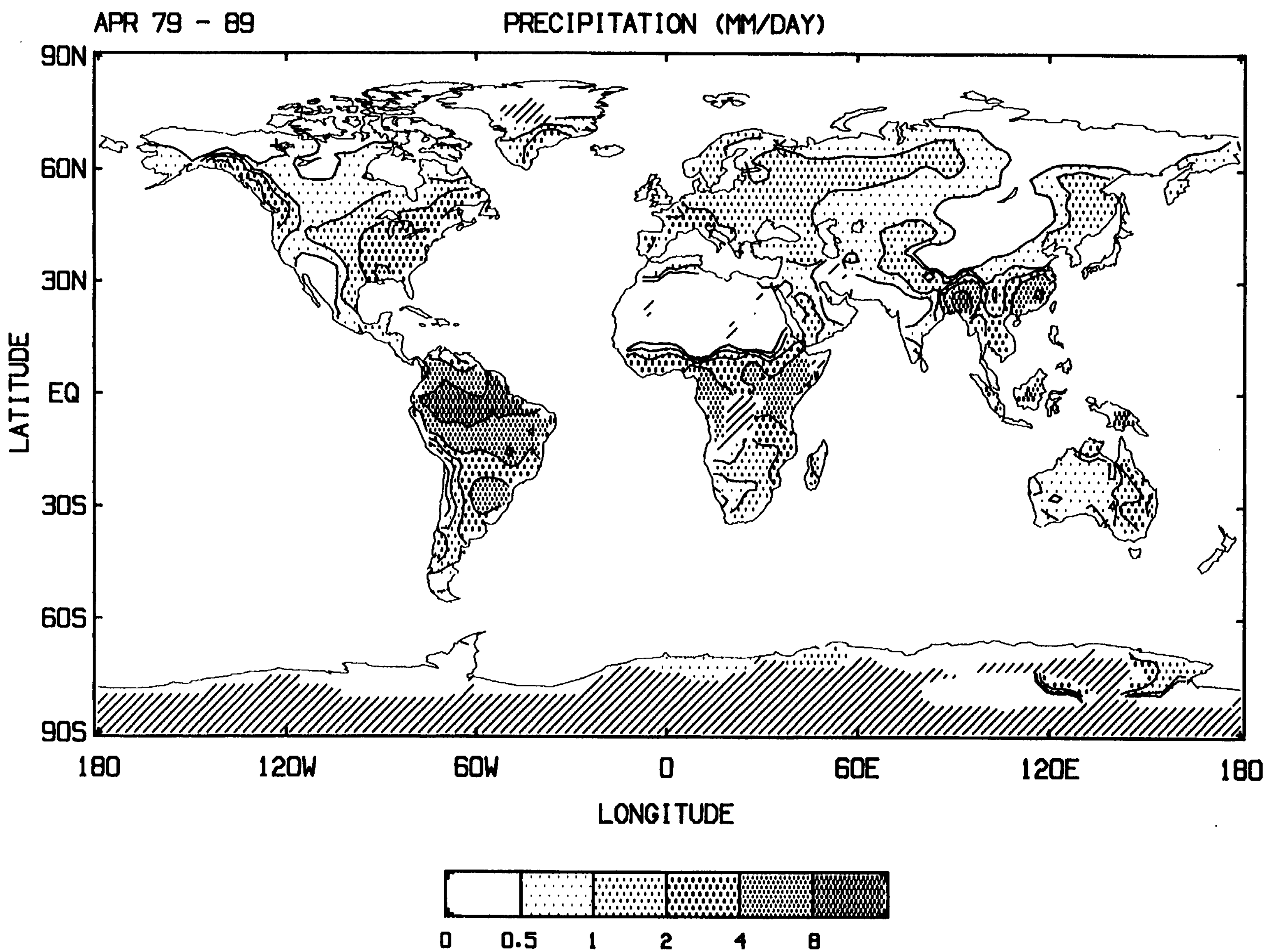
LONGITUDE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PRECIPITATION (MM/DAY)
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EQ
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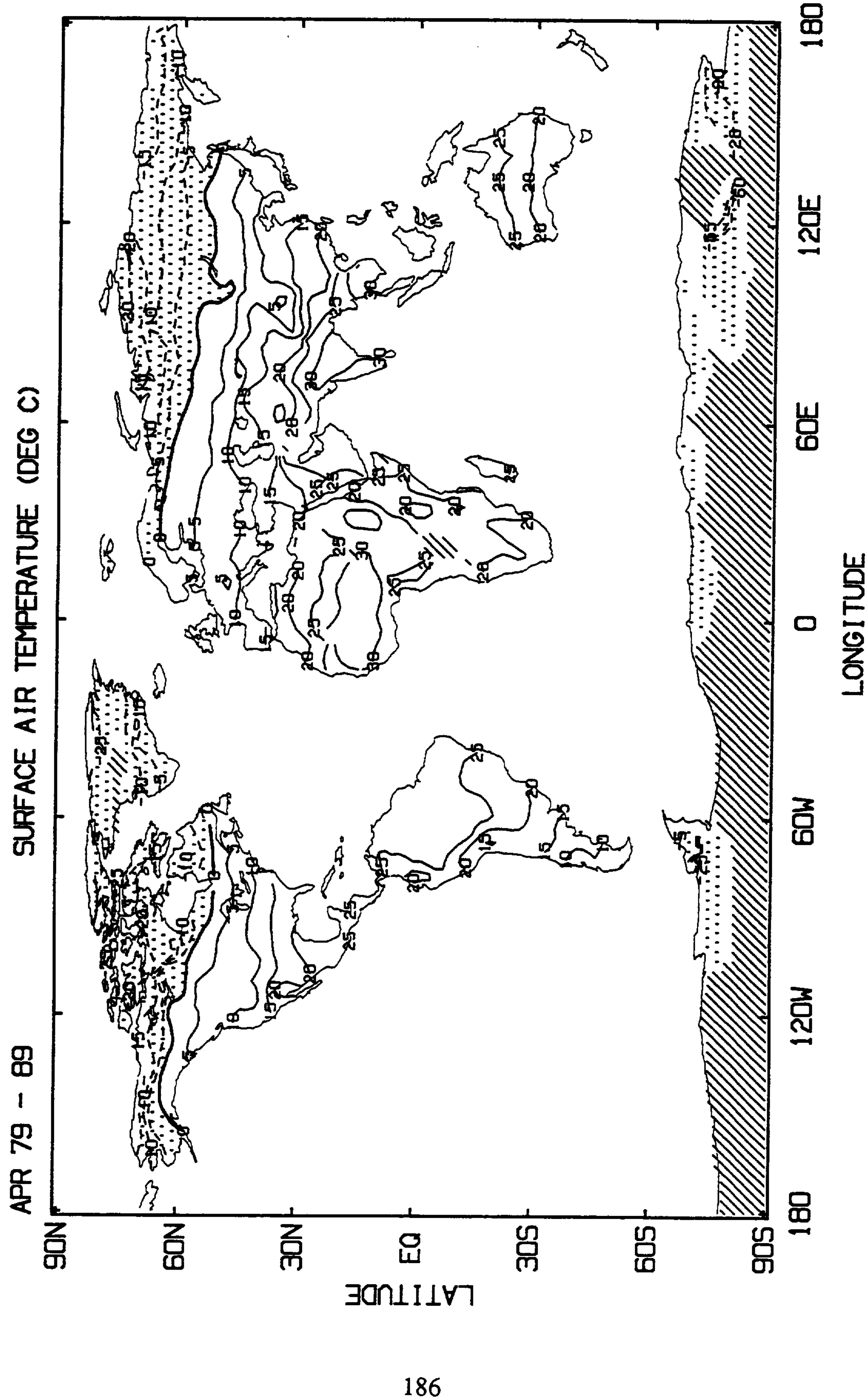
APR 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
LATITUDE
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EQ
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90S
LONGITUDE
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120W
60W
0
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120E
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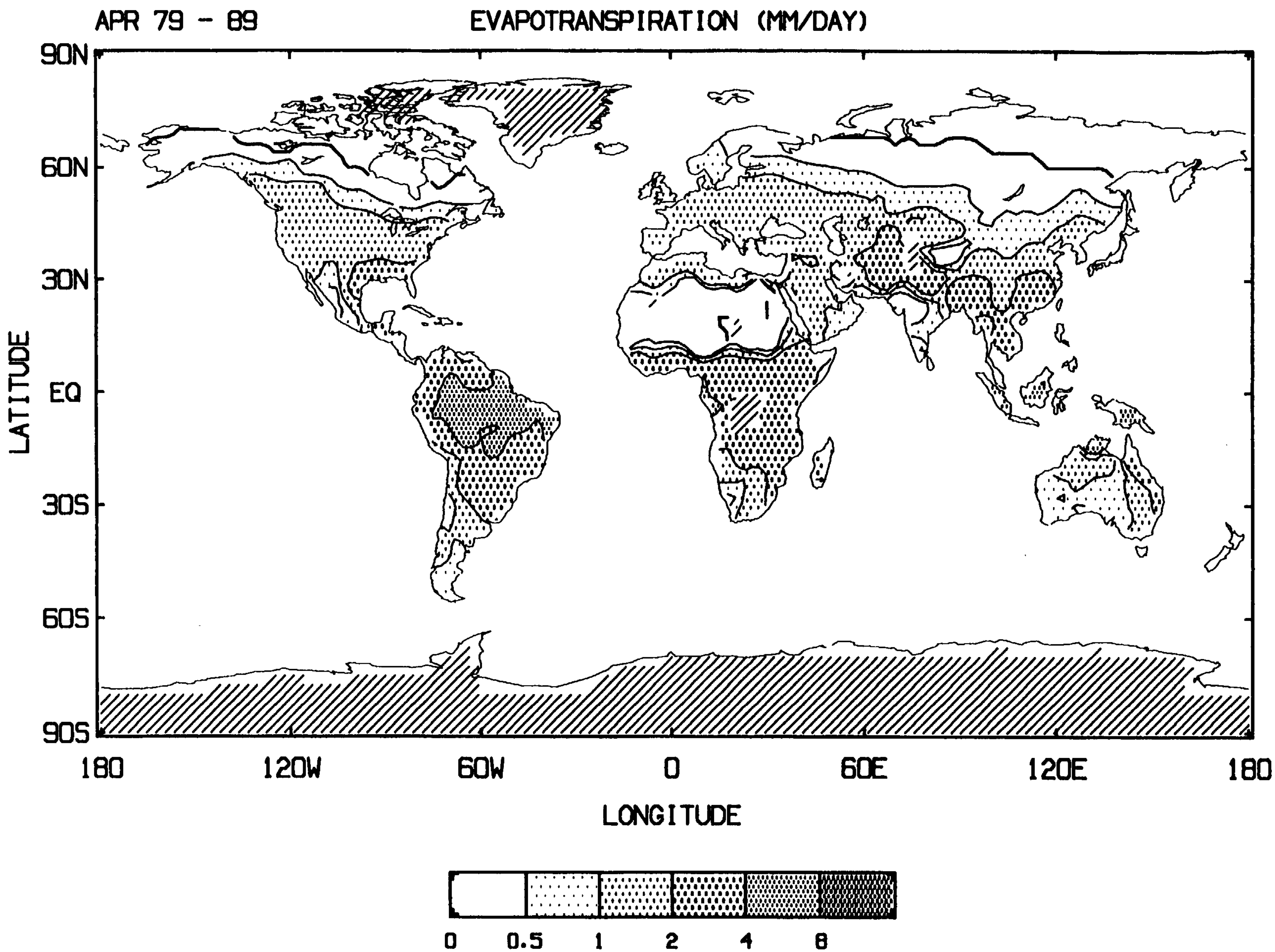
APR 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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30N
EQ
30S
60S
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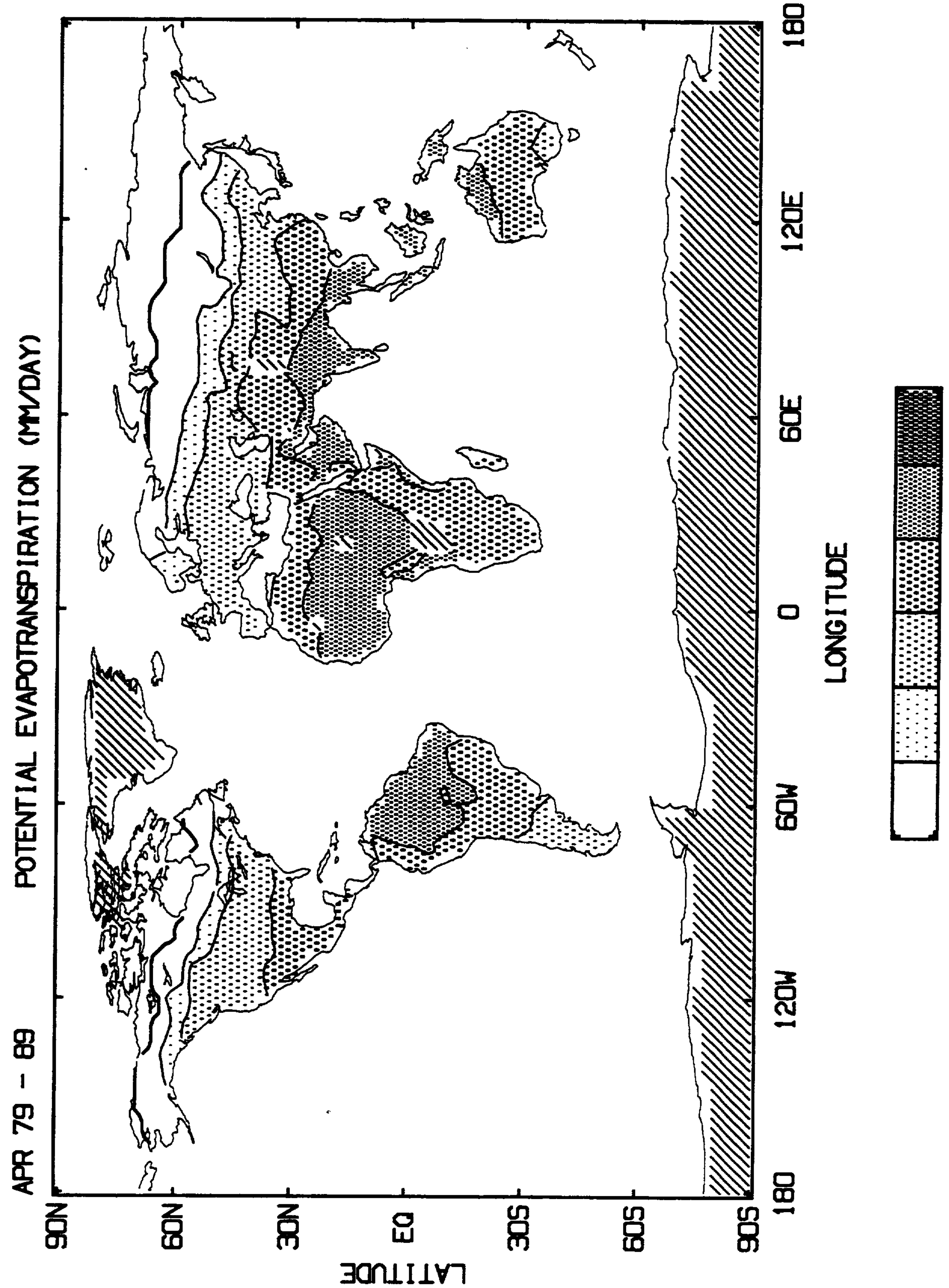

APR 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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30N
EQ
30S
60S
90S
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LONGITUDE
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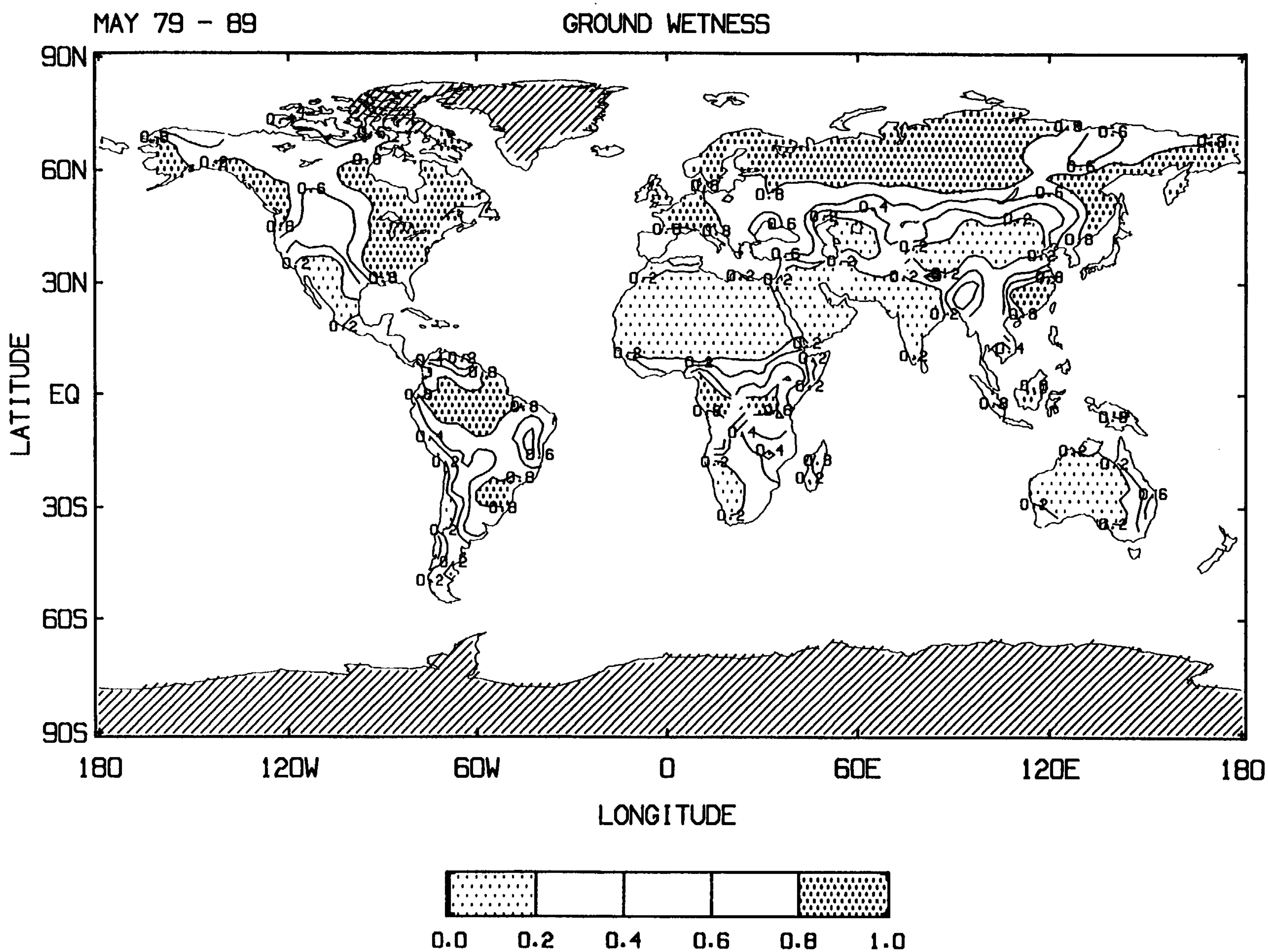
MAY


MAY 79 - 89
GROUND WETNESS
LATITUDE
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EQ
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60S
90S
LONGITUDE
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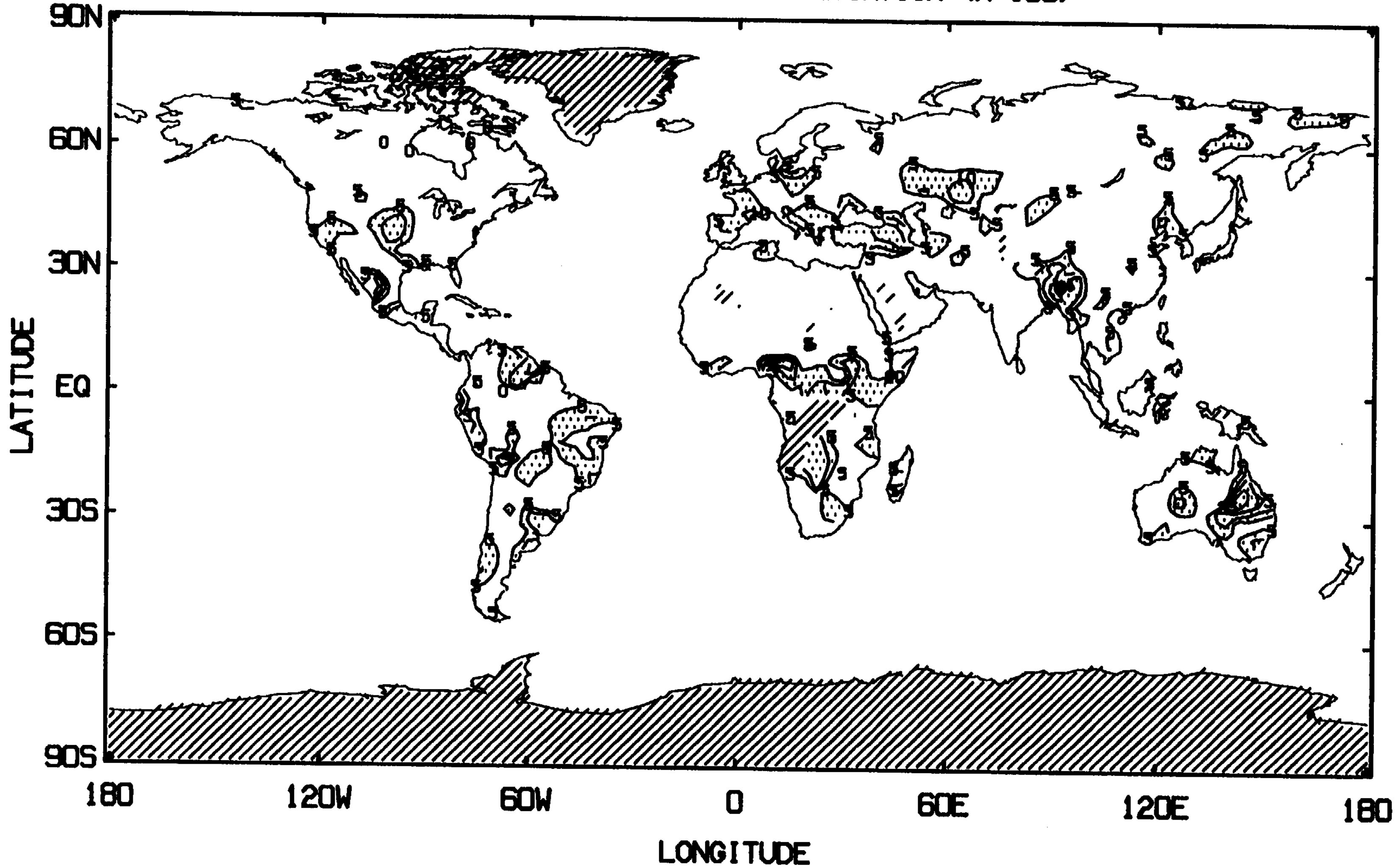
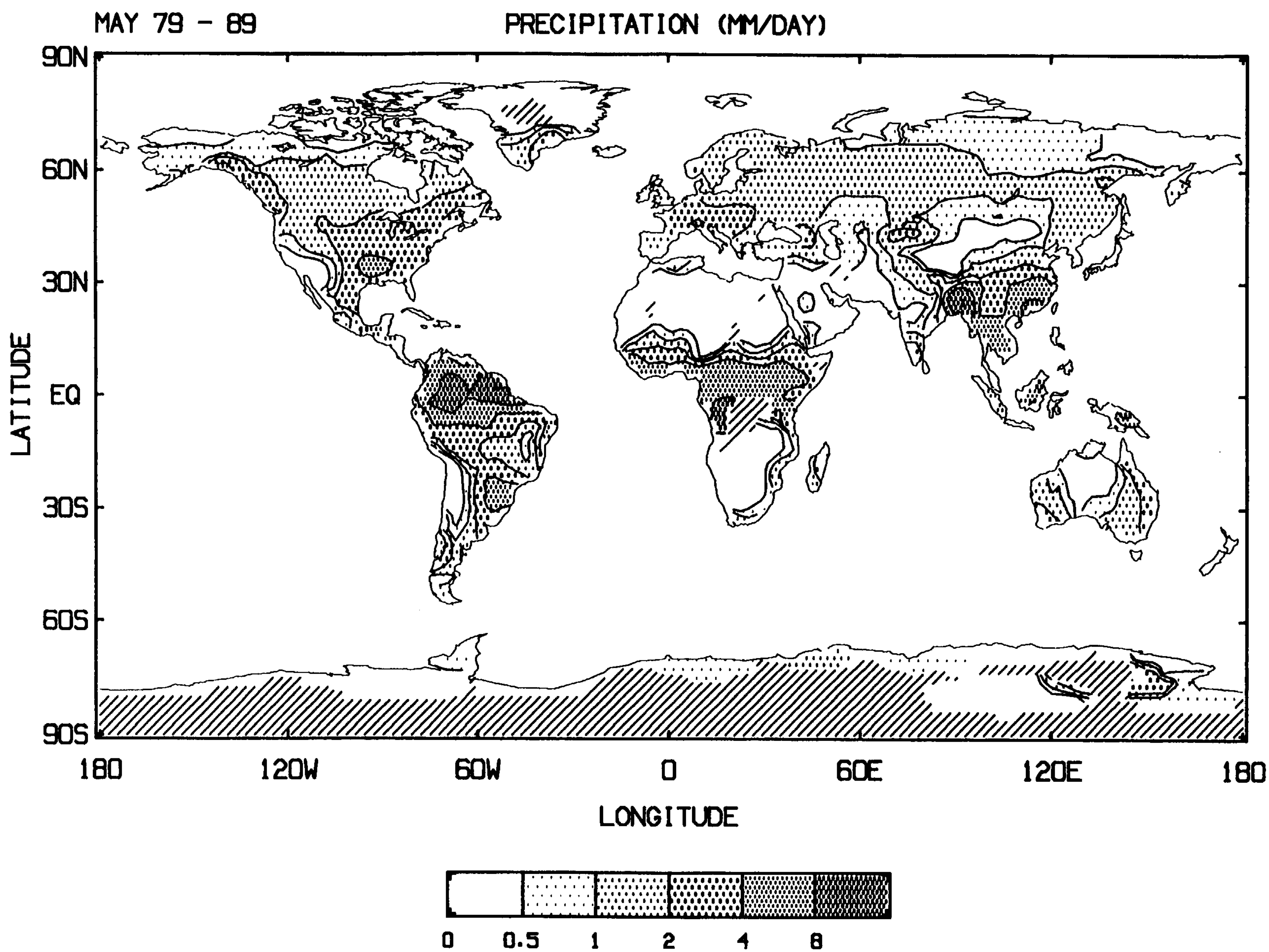
MAY 79 - 89 GROUND WETNESS STANDARD DEVIATION (X 100)




MAY 79 - 89
PRECIPITATION (MM/DAY)
90N
60N
30N
EQ
30S
60S
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LATITUDE
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60W
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60E
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LONGITUDE
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4
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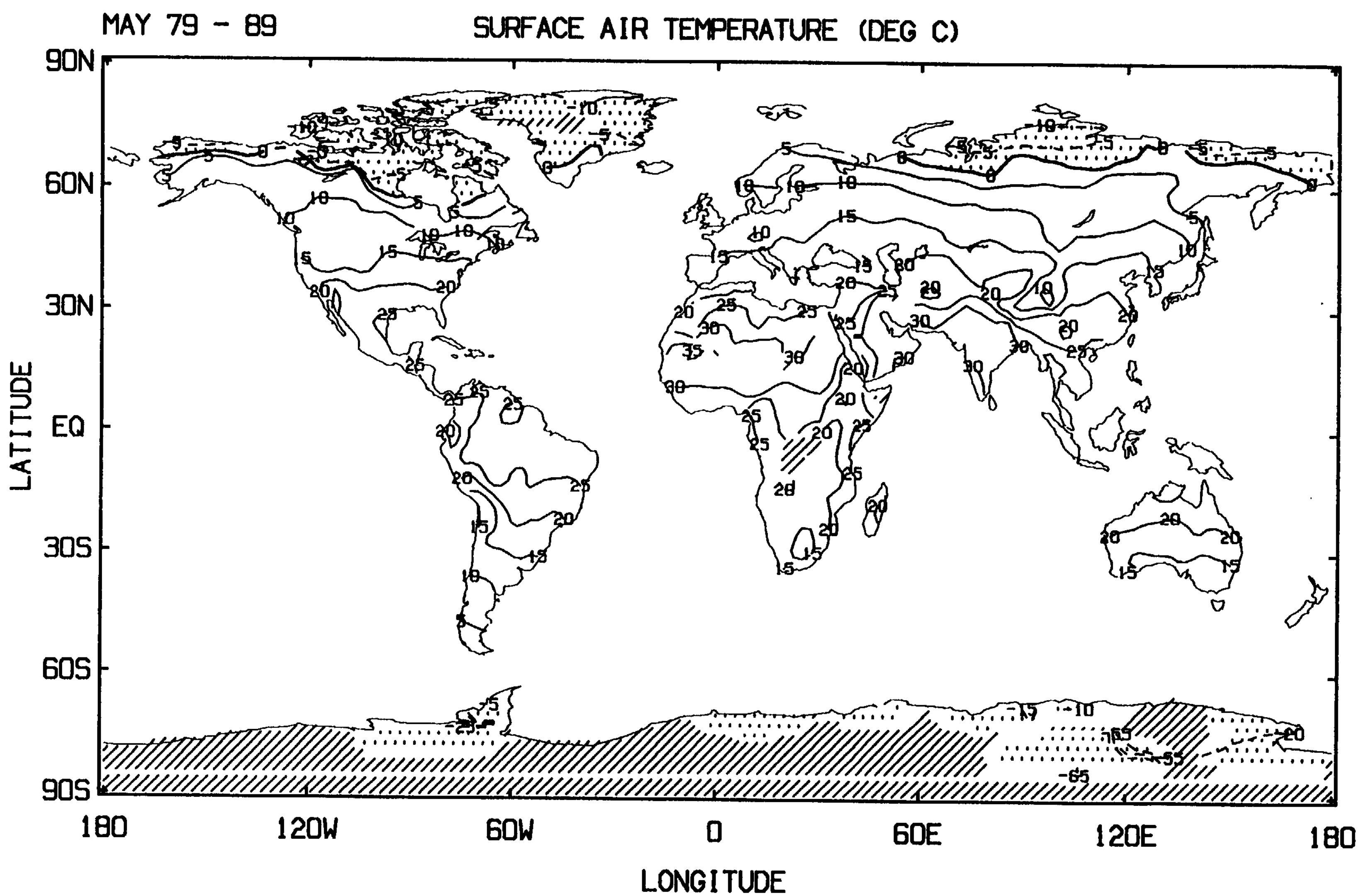
MAY 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
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LATITUDE
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60W
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120E
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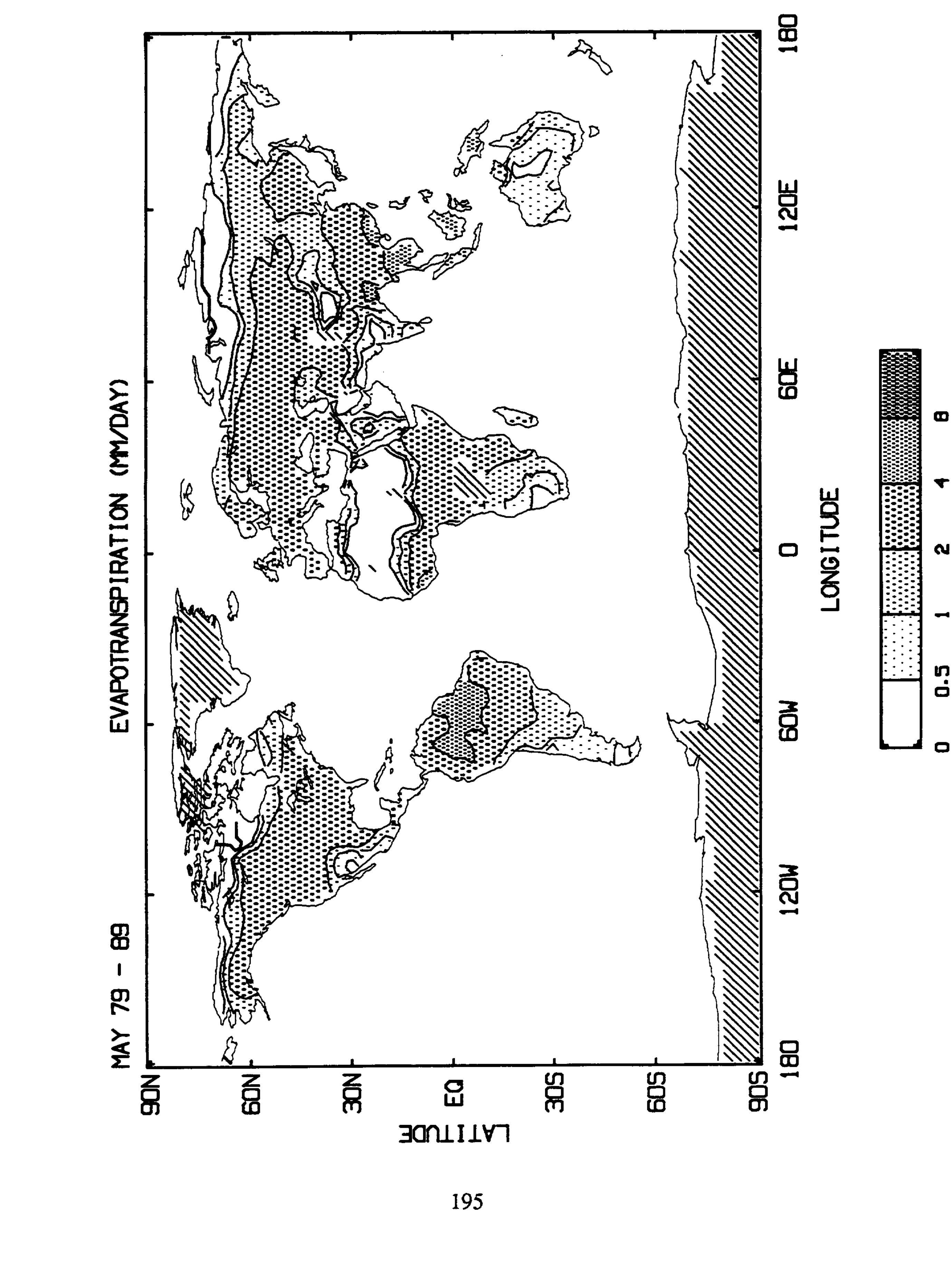
LONGITUDE



MAY 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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EQ
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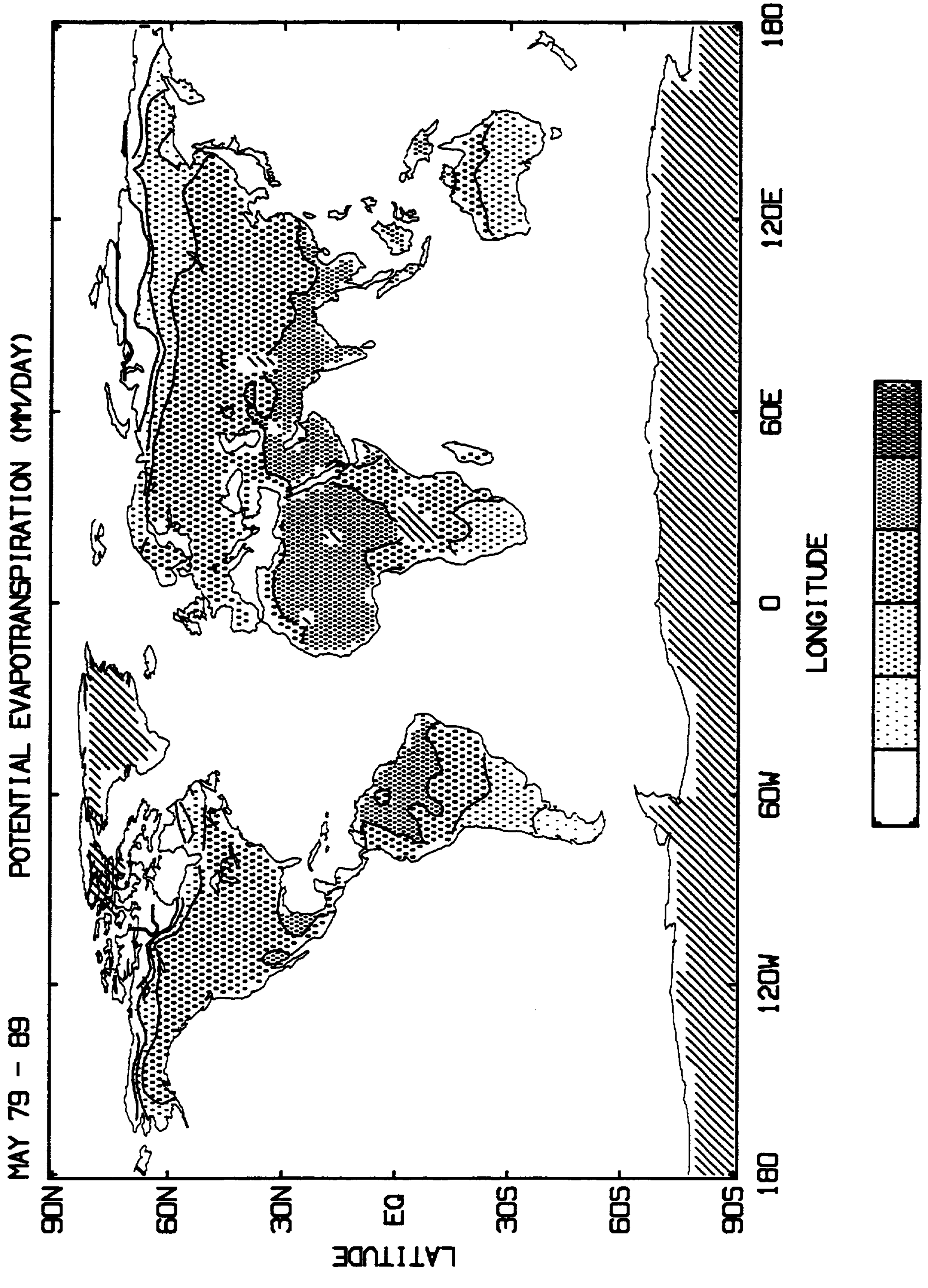

MAY 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
90N
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EQ
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60S
90S
LATITUDE
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LONGITUDE
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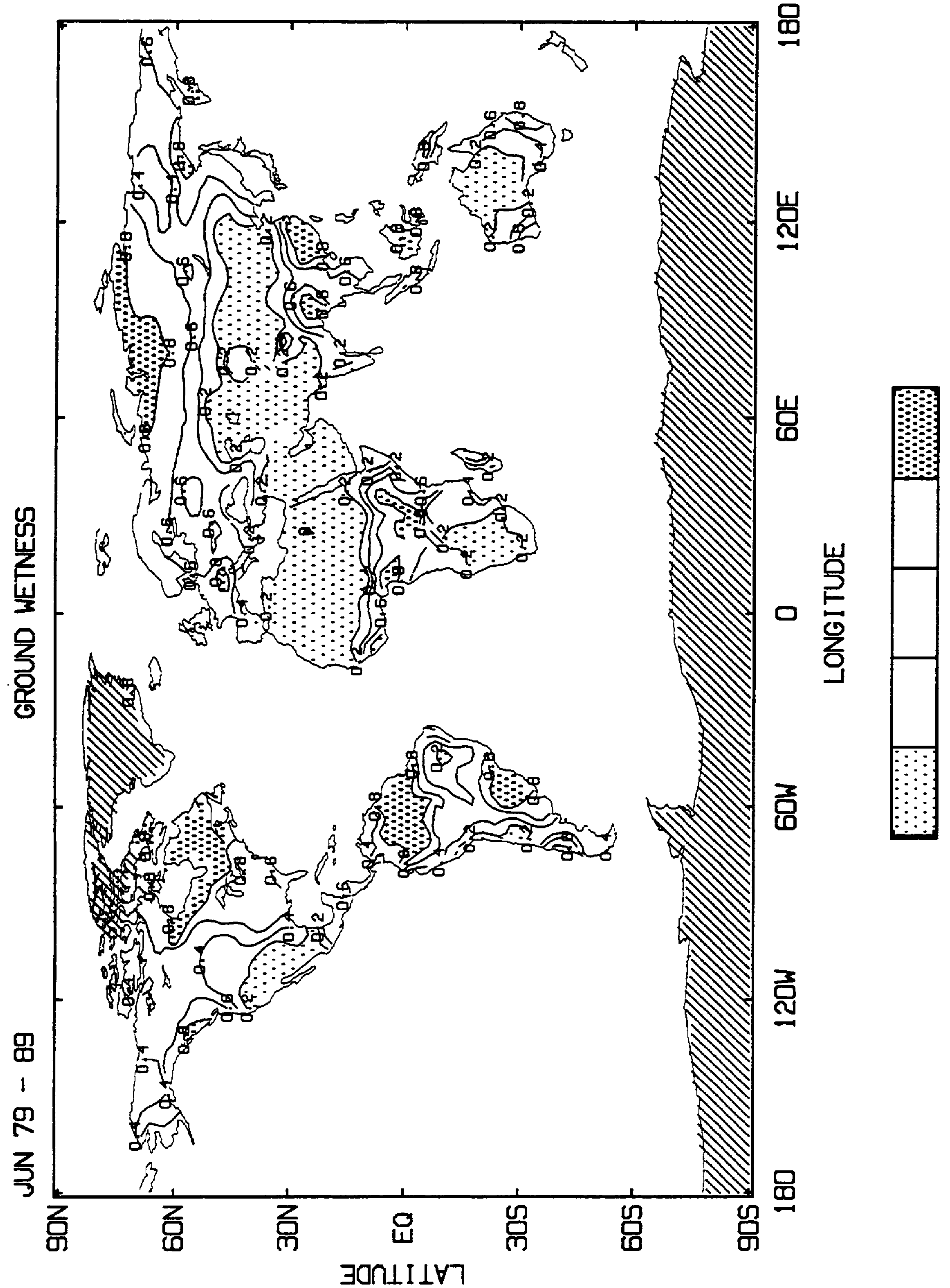
8

<u>JUNE</u>


JUN 79 - 89
GROUND WETNESS
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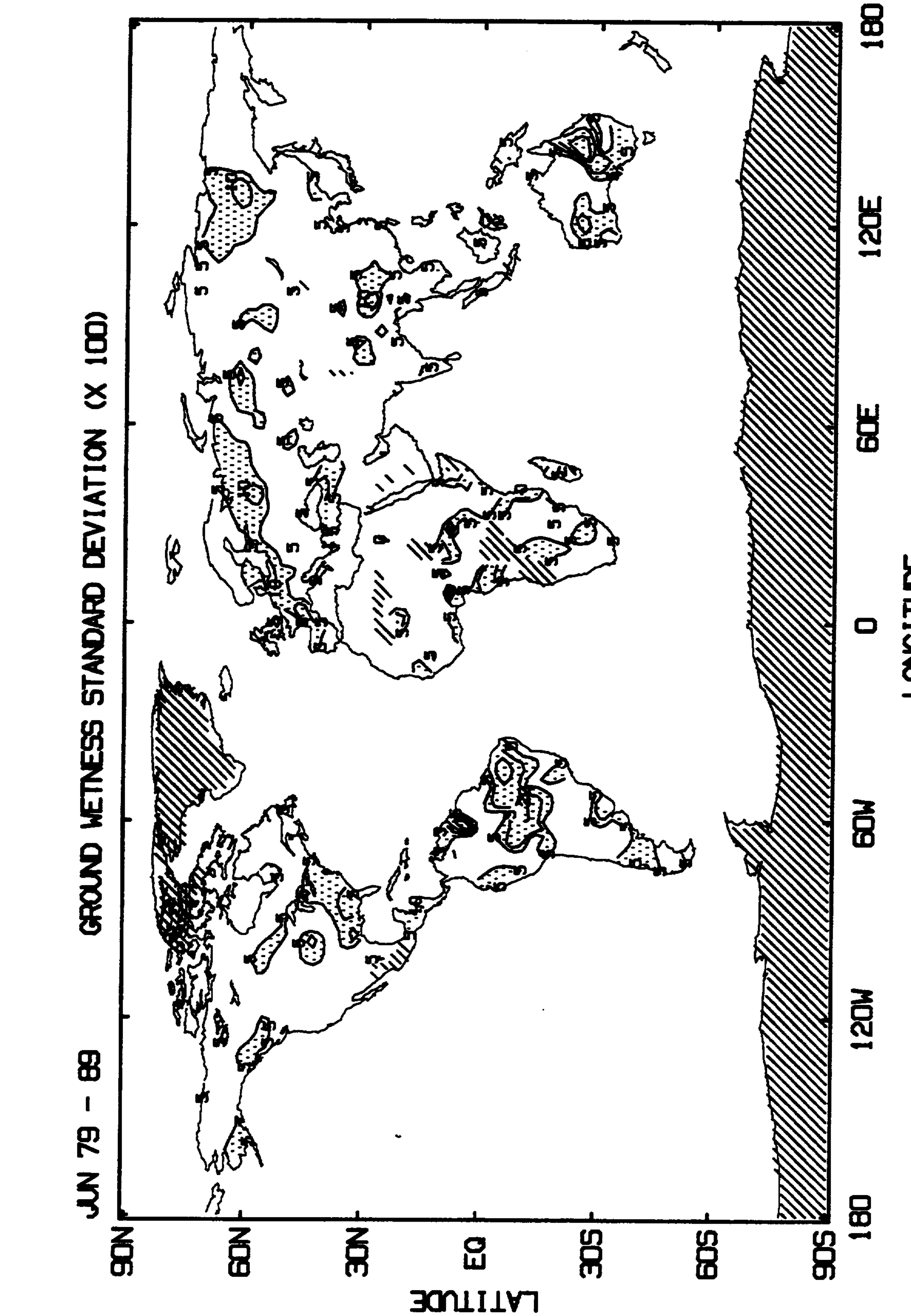

JUN 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
LATITUDE
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EQ
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90S
LONGITUDE
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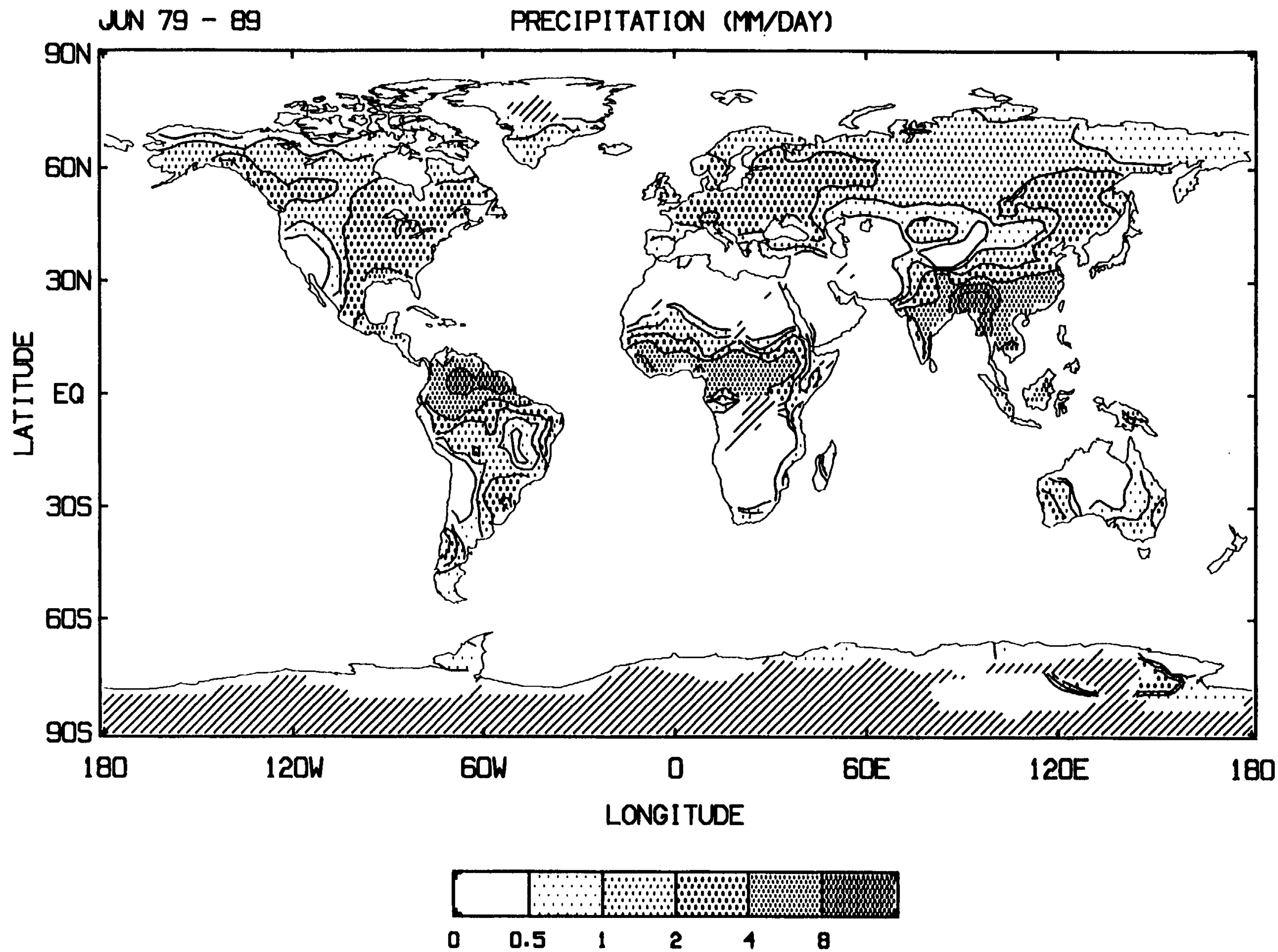
JUN 79 - 89
PRECIPITATION (MM/DAY)
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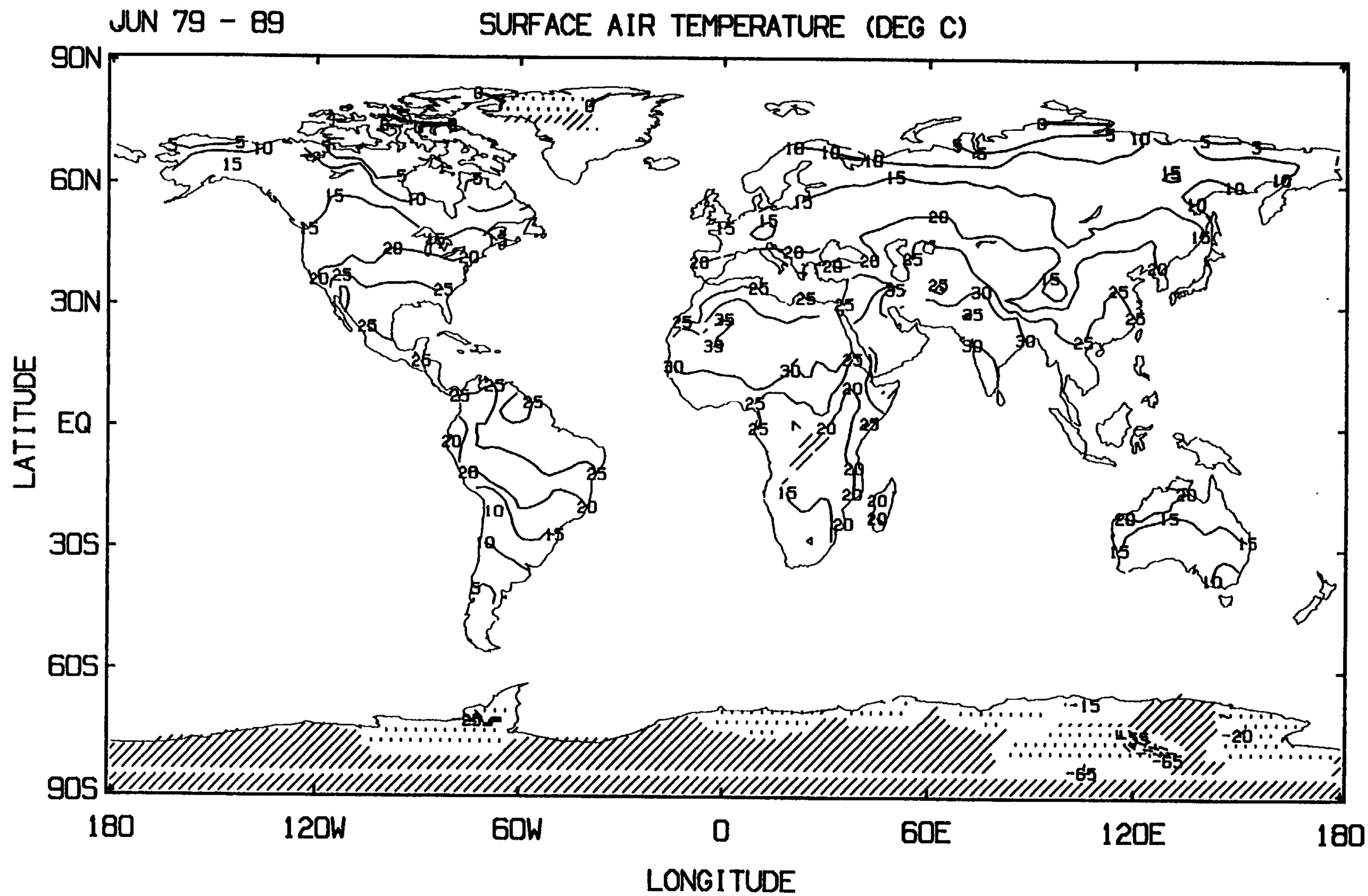
C 3


JUN 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
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120E
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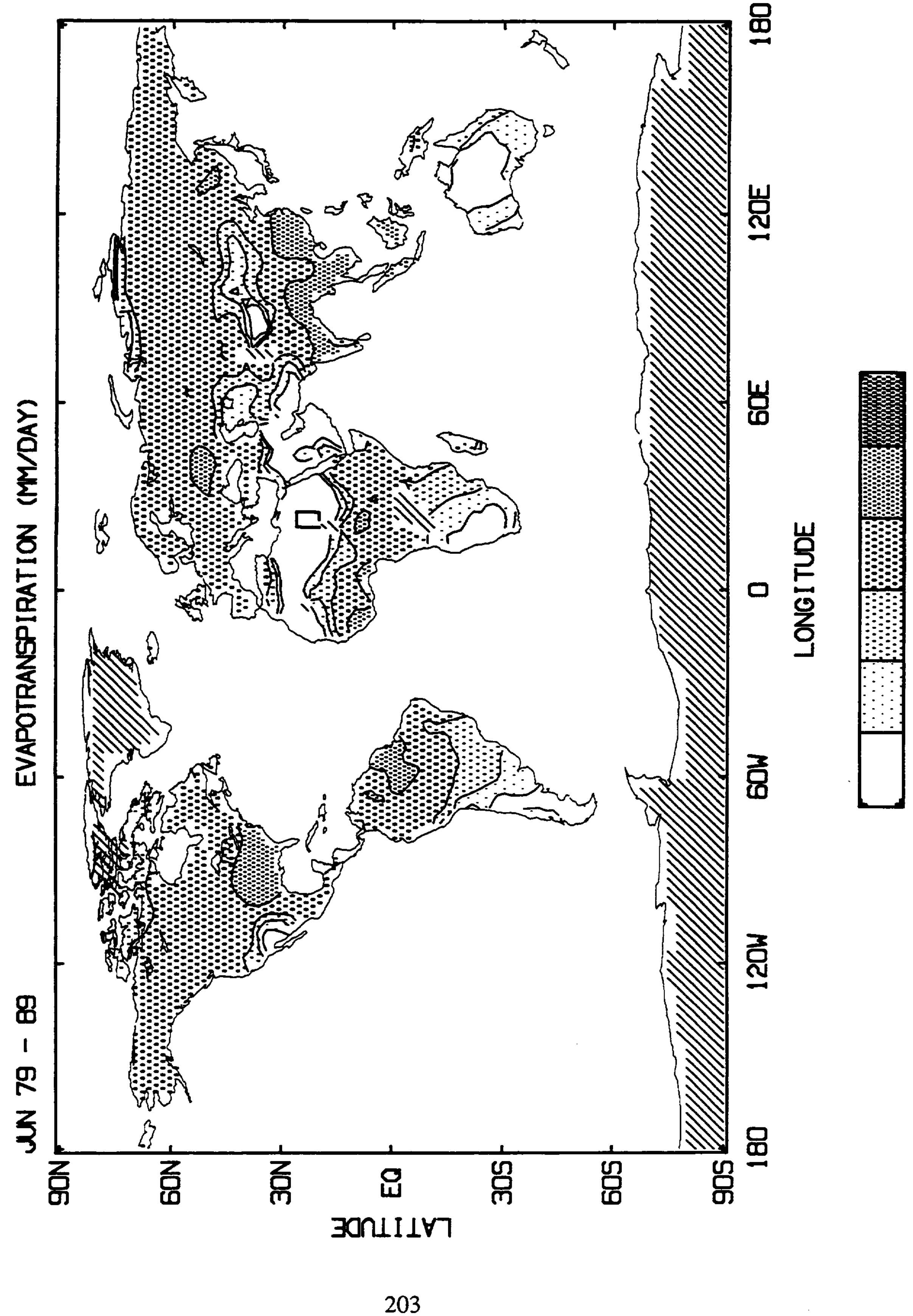

JUN 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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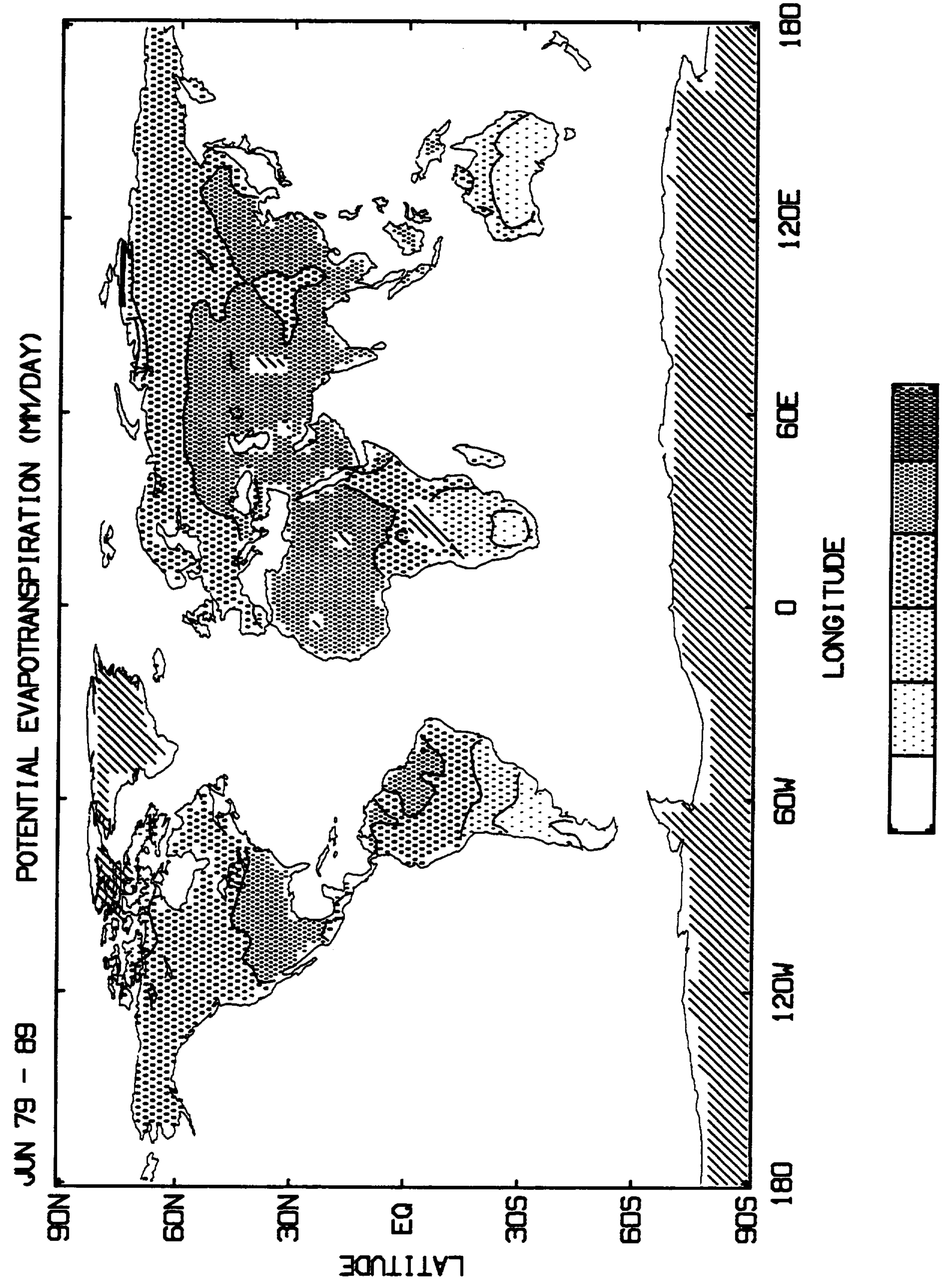
JUN 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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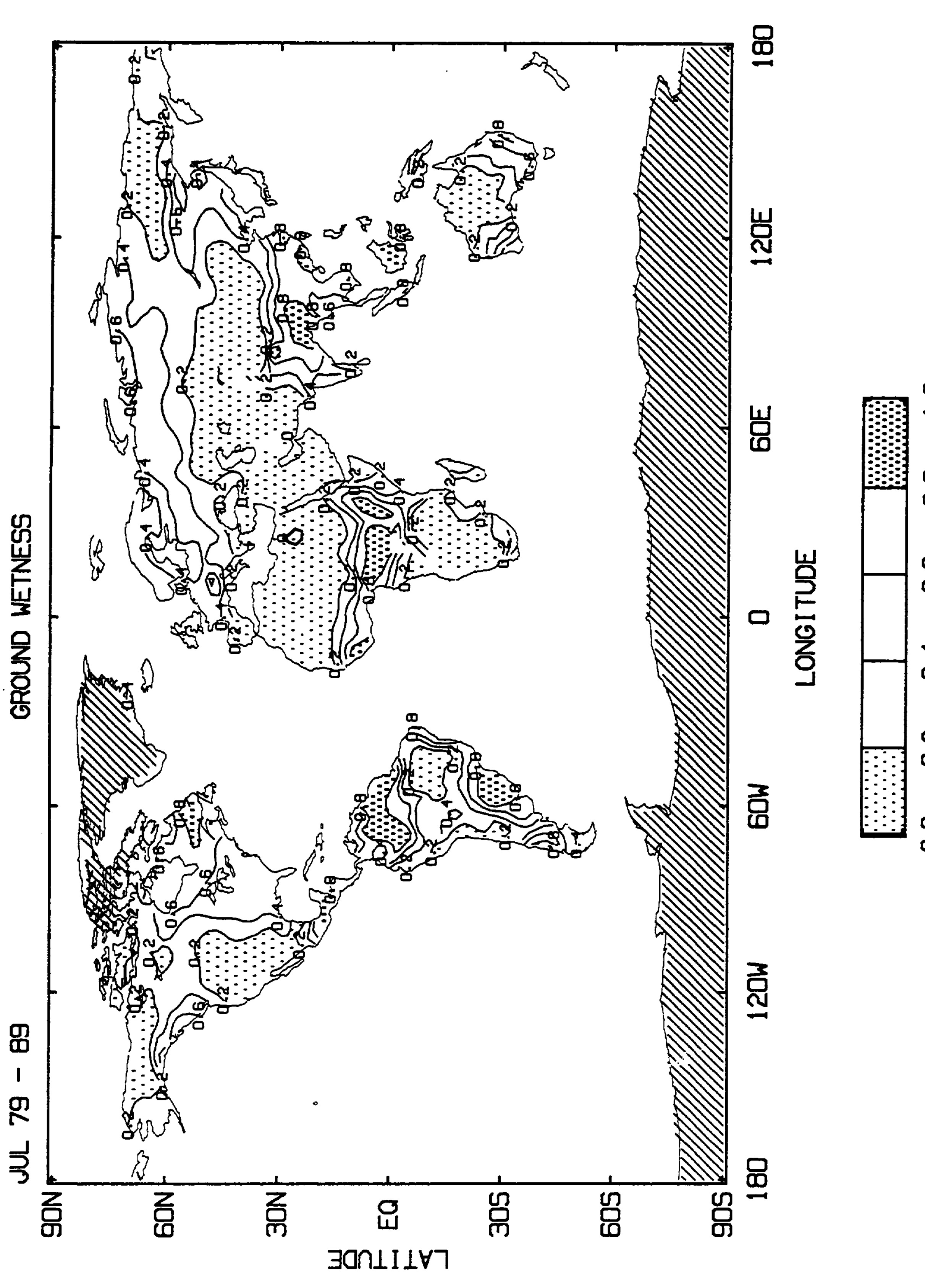
JULY


JUL 79 - 89
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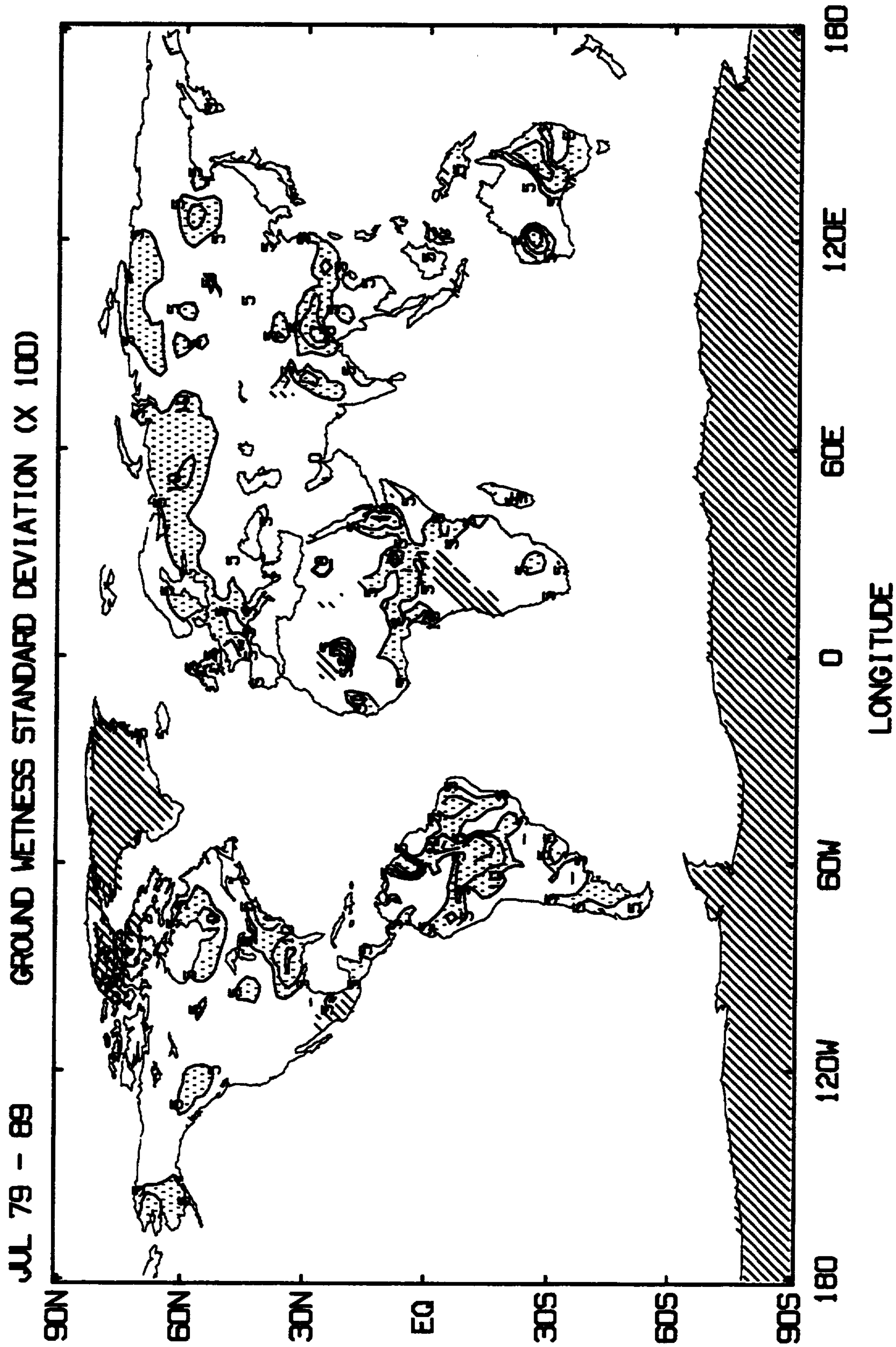
JUL 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
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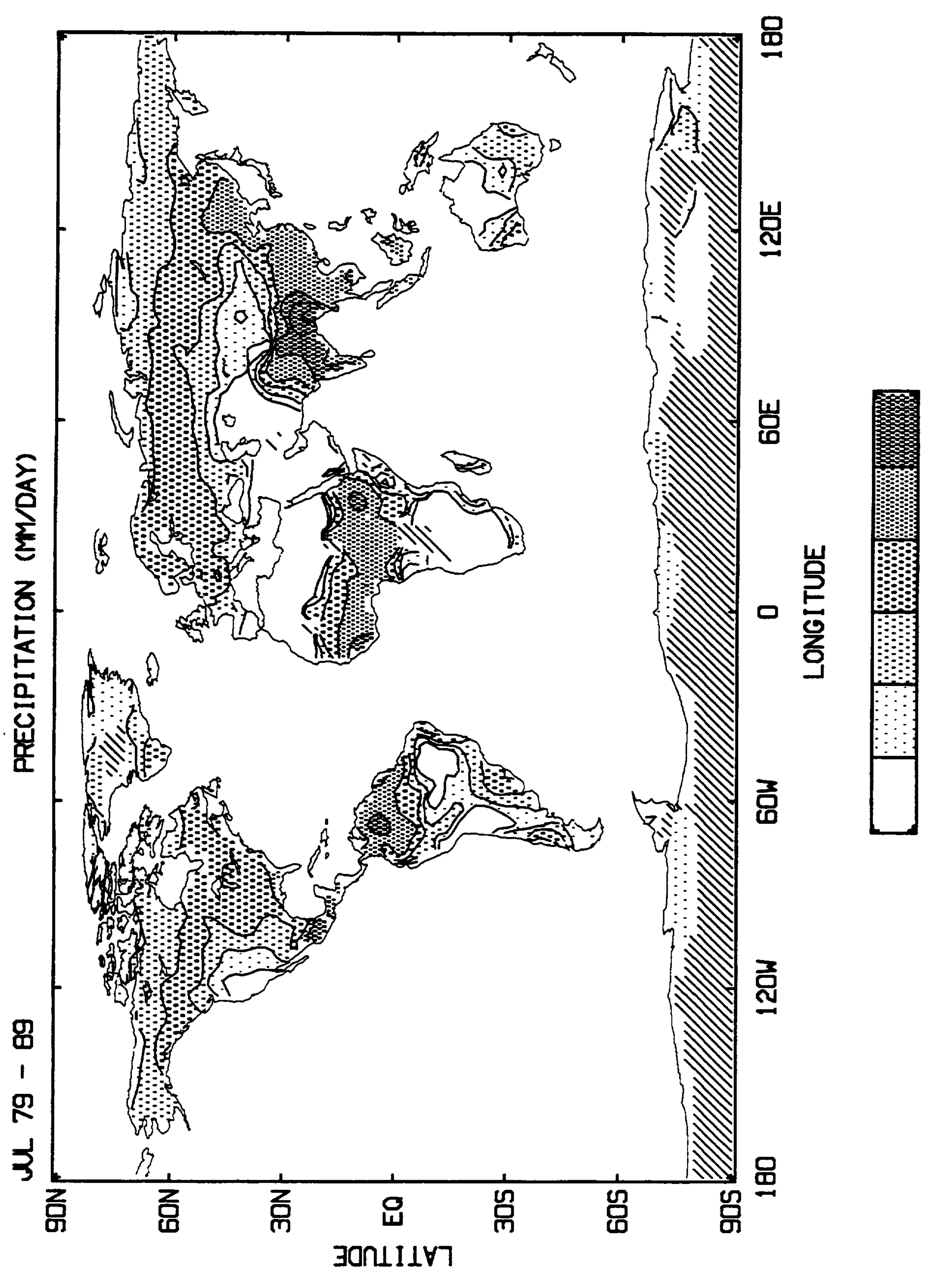
JUL 79 - 89
PRECIPITATION (MM/DAY)
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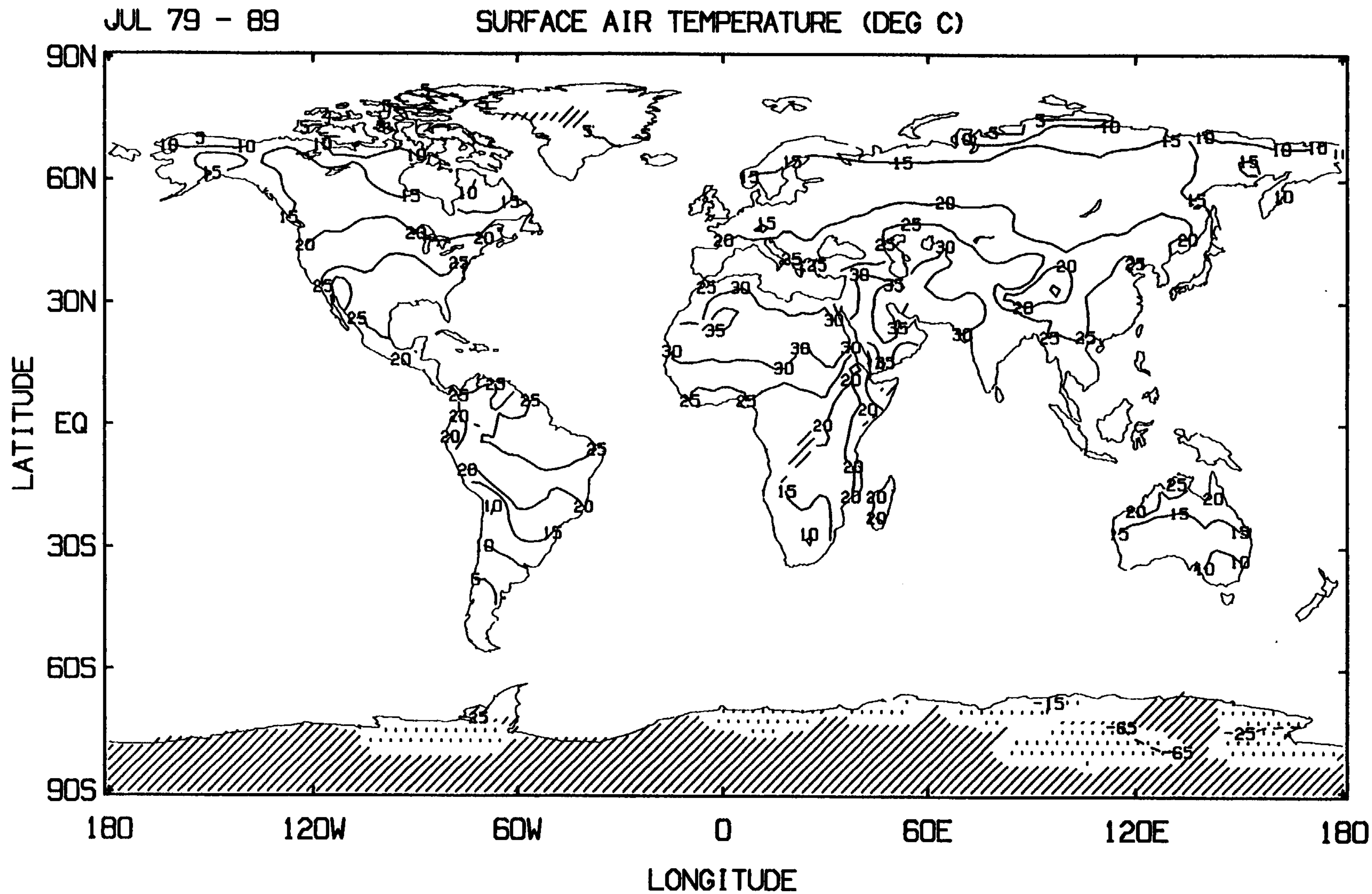
JUL 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
LATITUDE
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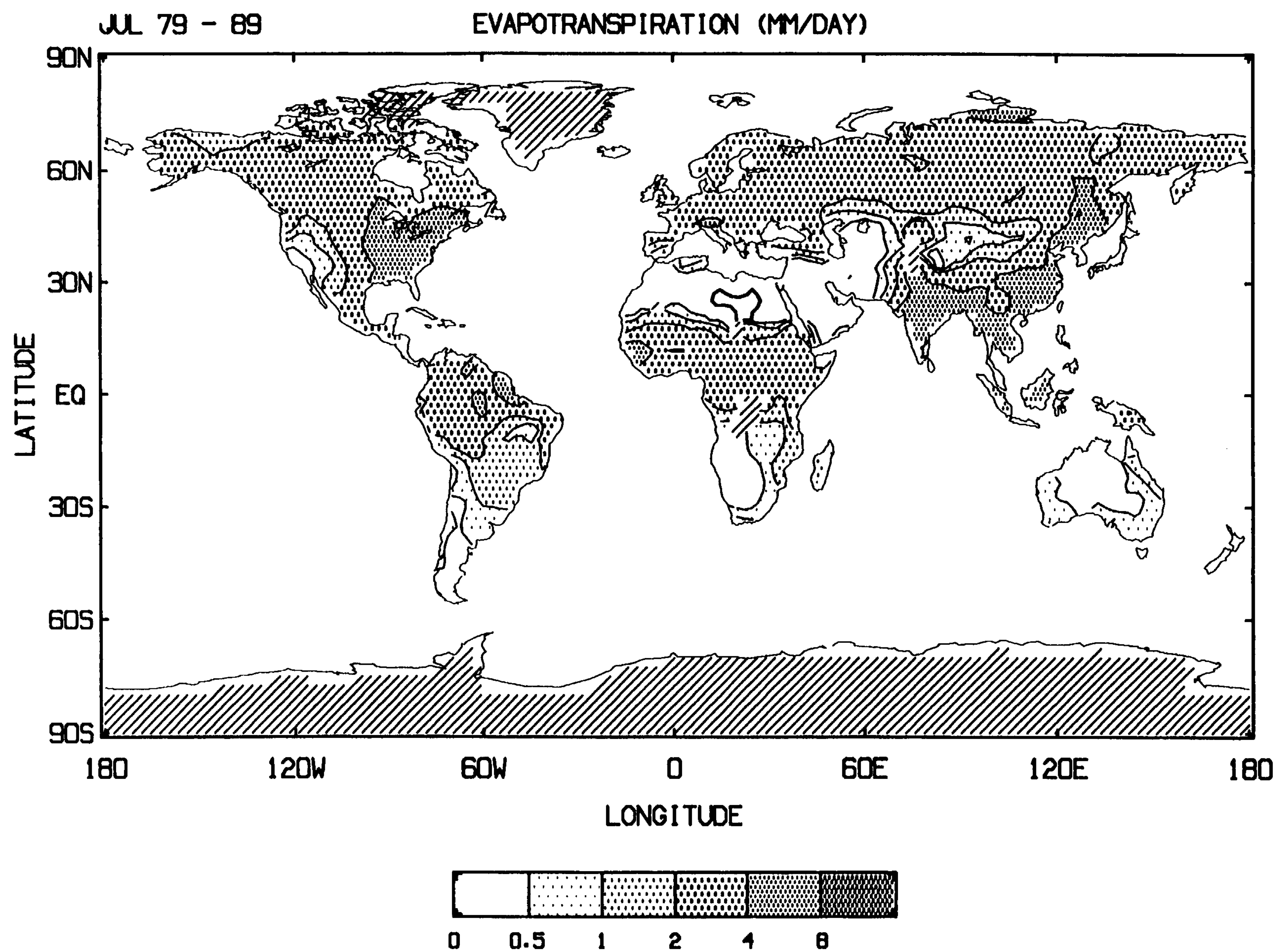
JUL 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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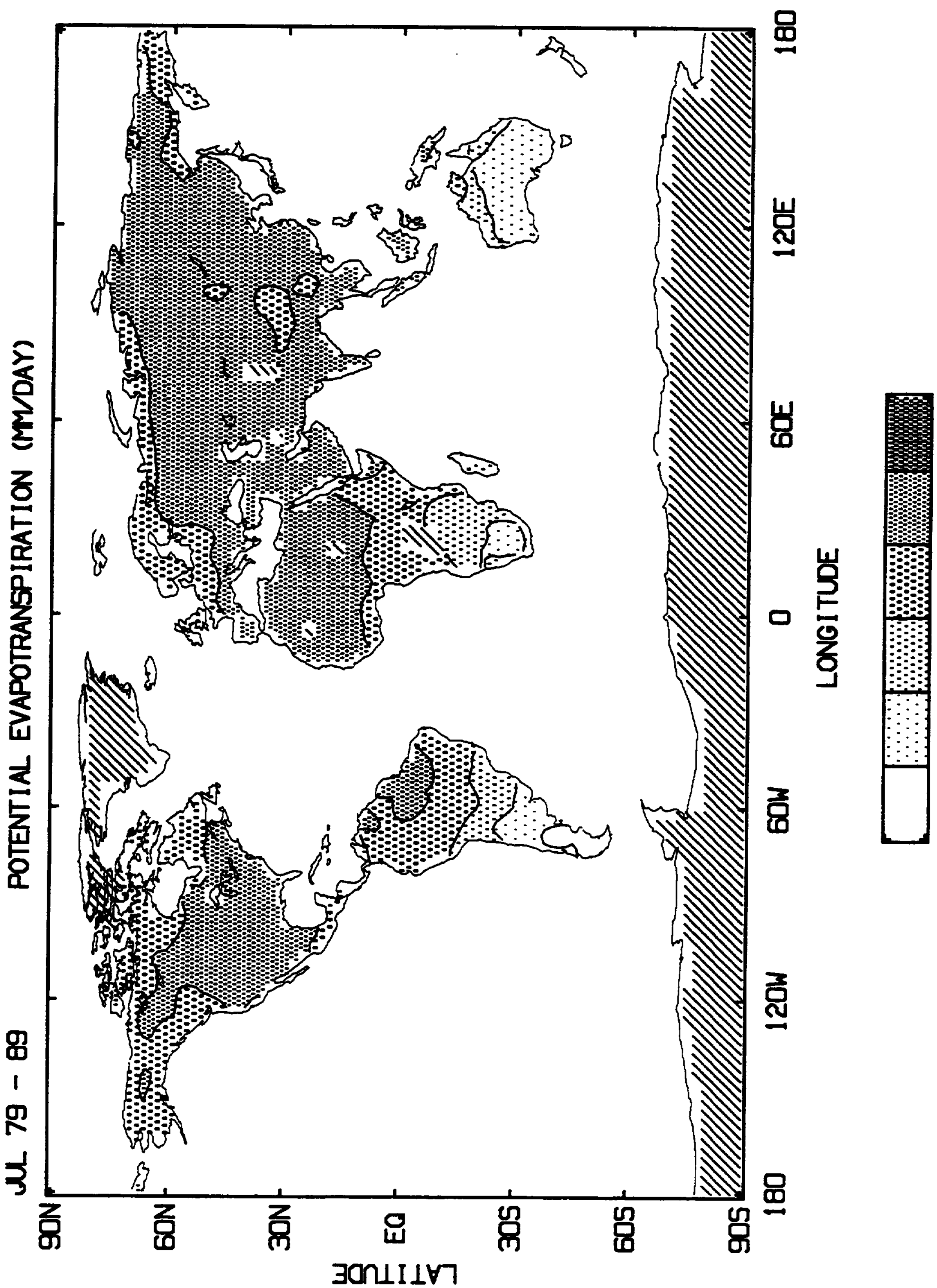
JUL 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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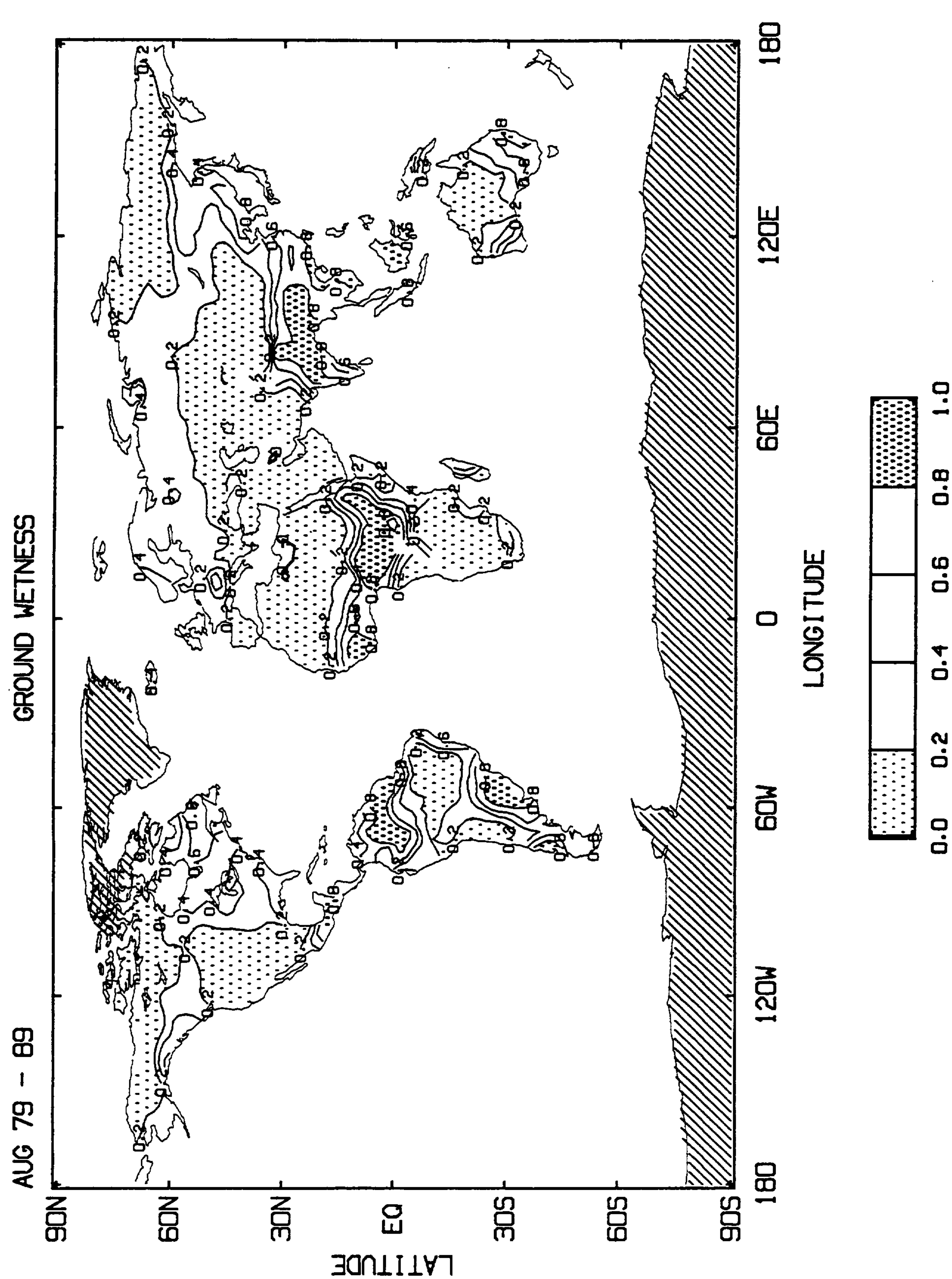
AUGUST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GROUND WETNESS
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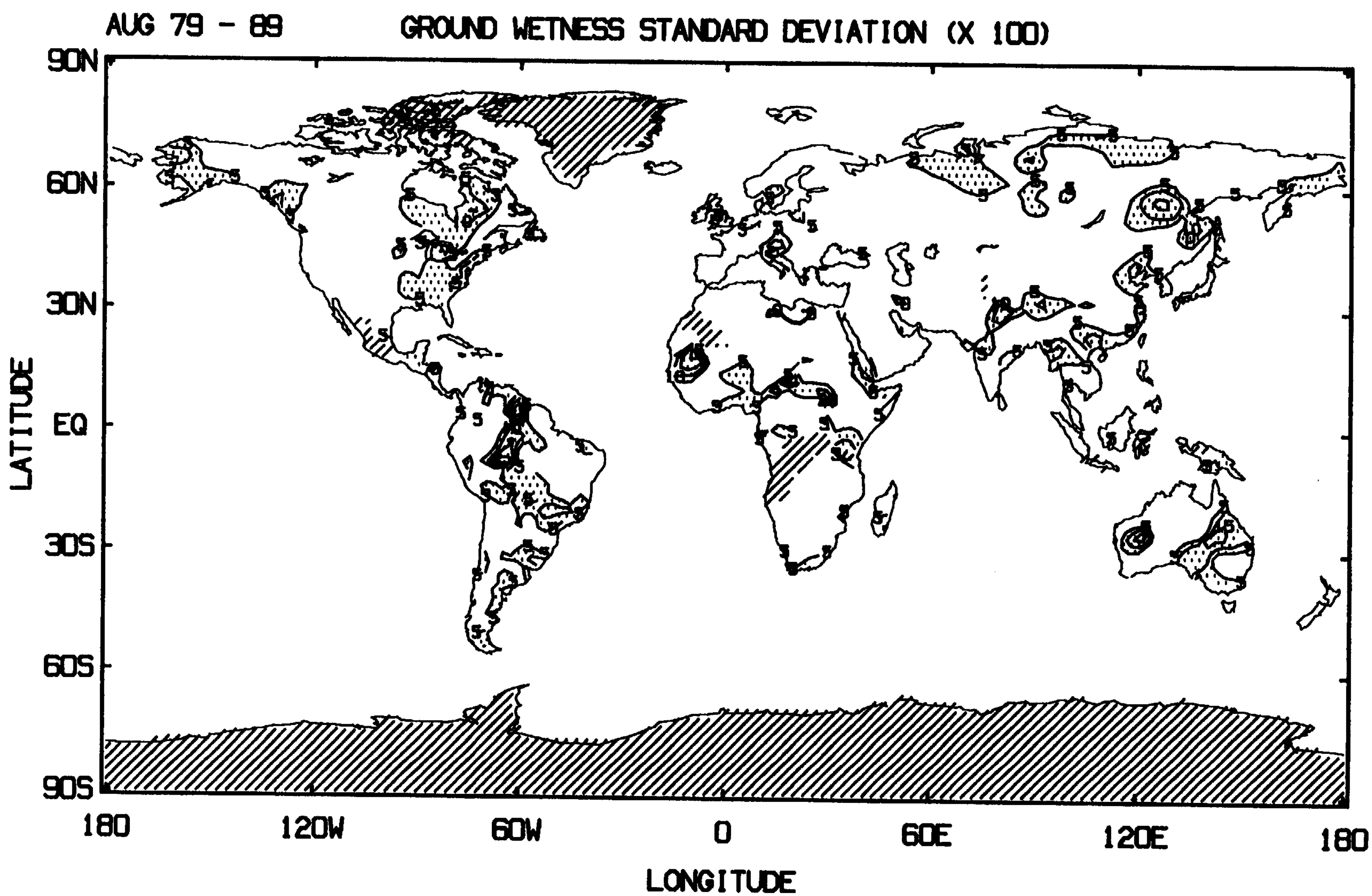
AUG 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
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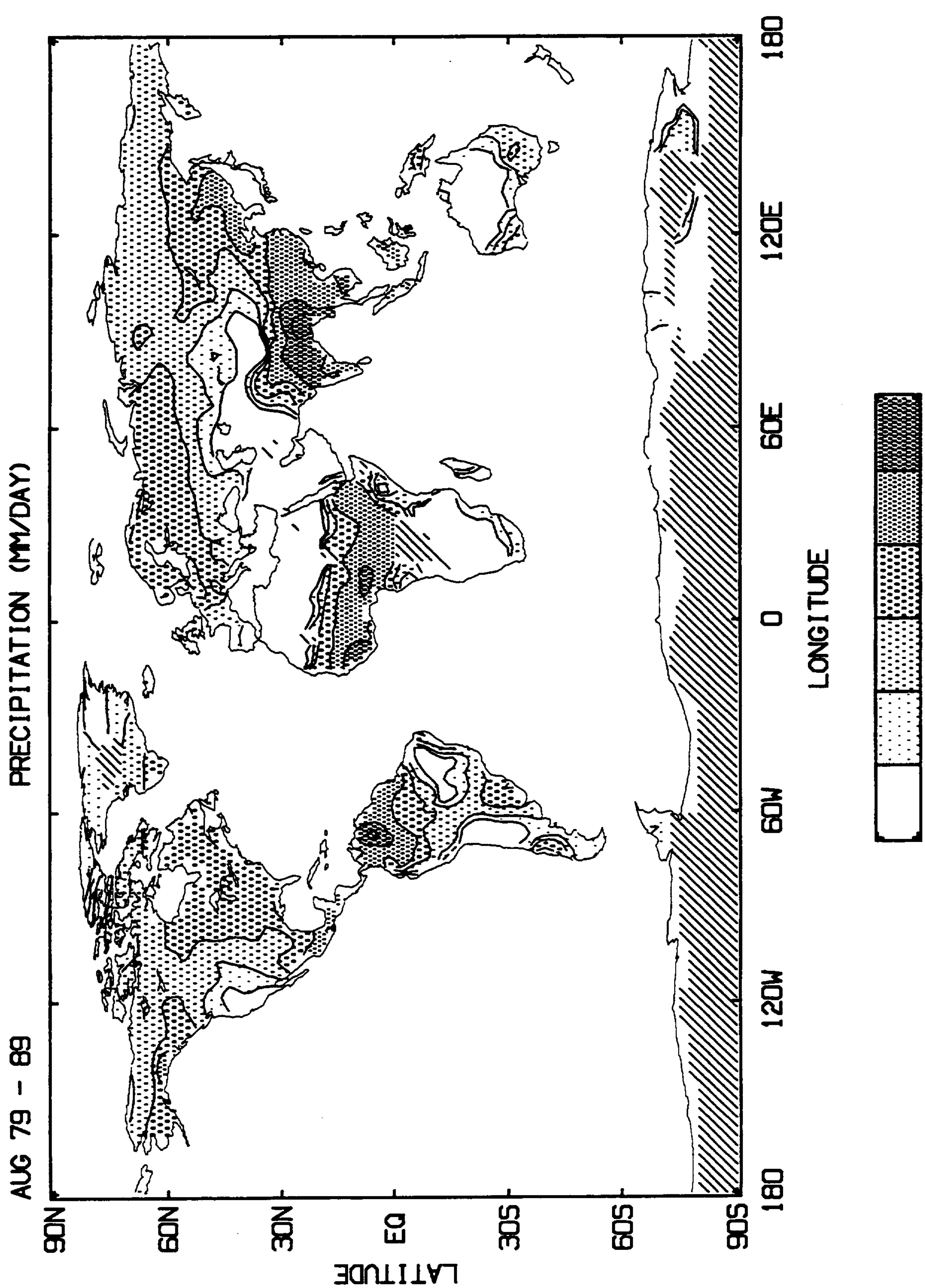
LONGITUDE


AUG 79 - 89
PRECIPITATION (MM/DAY)
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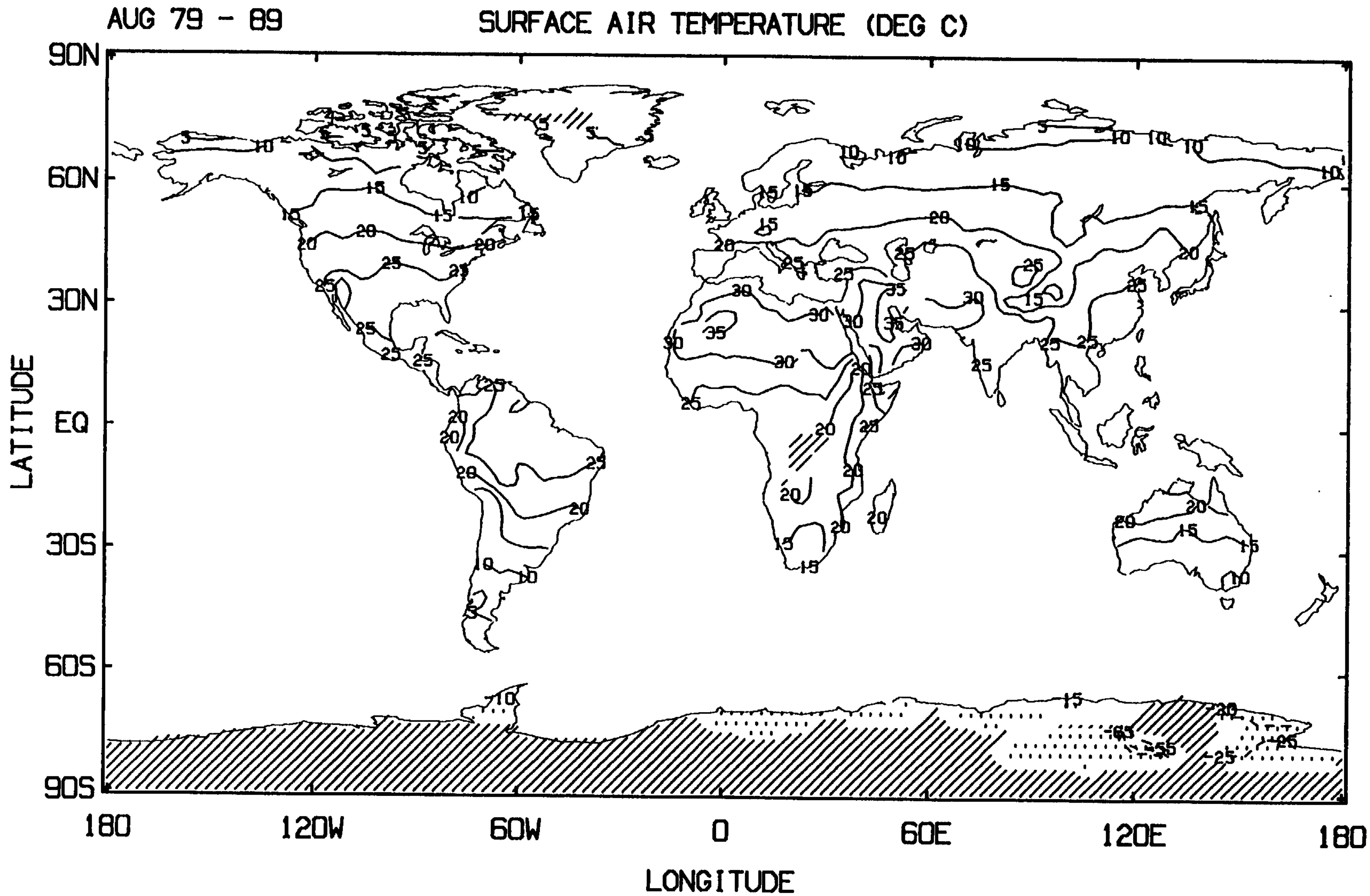
AUG 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
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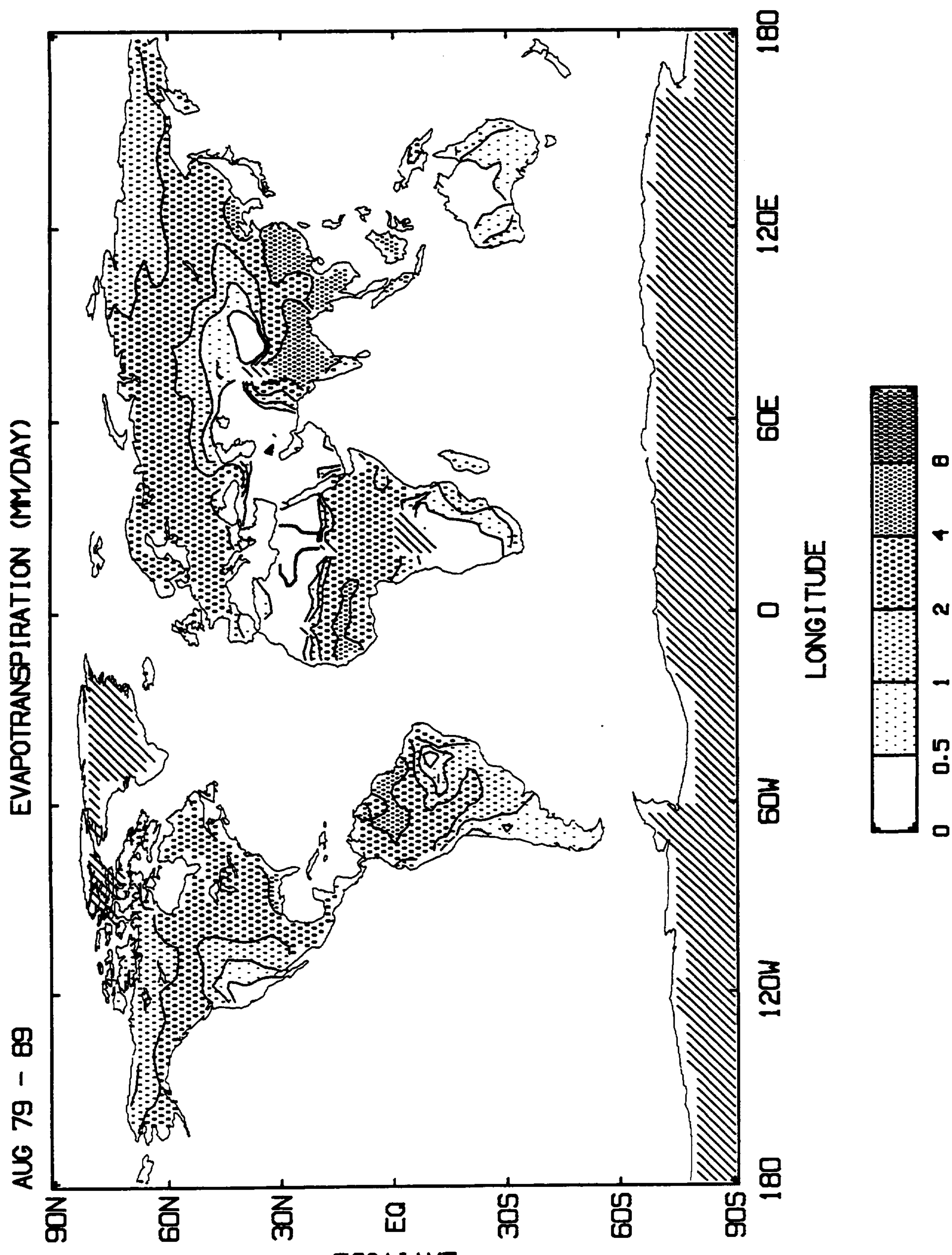
LONGITUDE


AUG 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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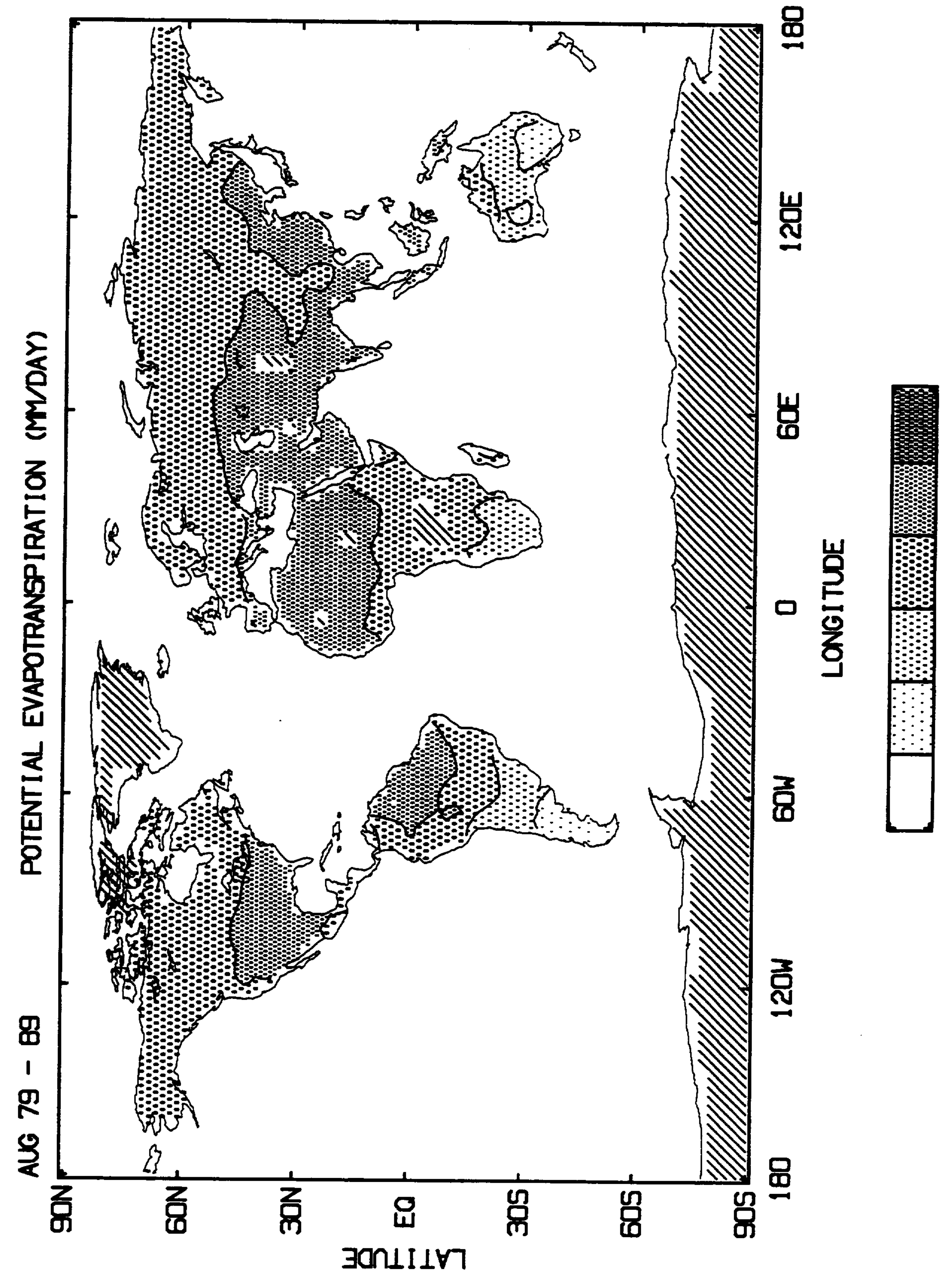
AUG 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
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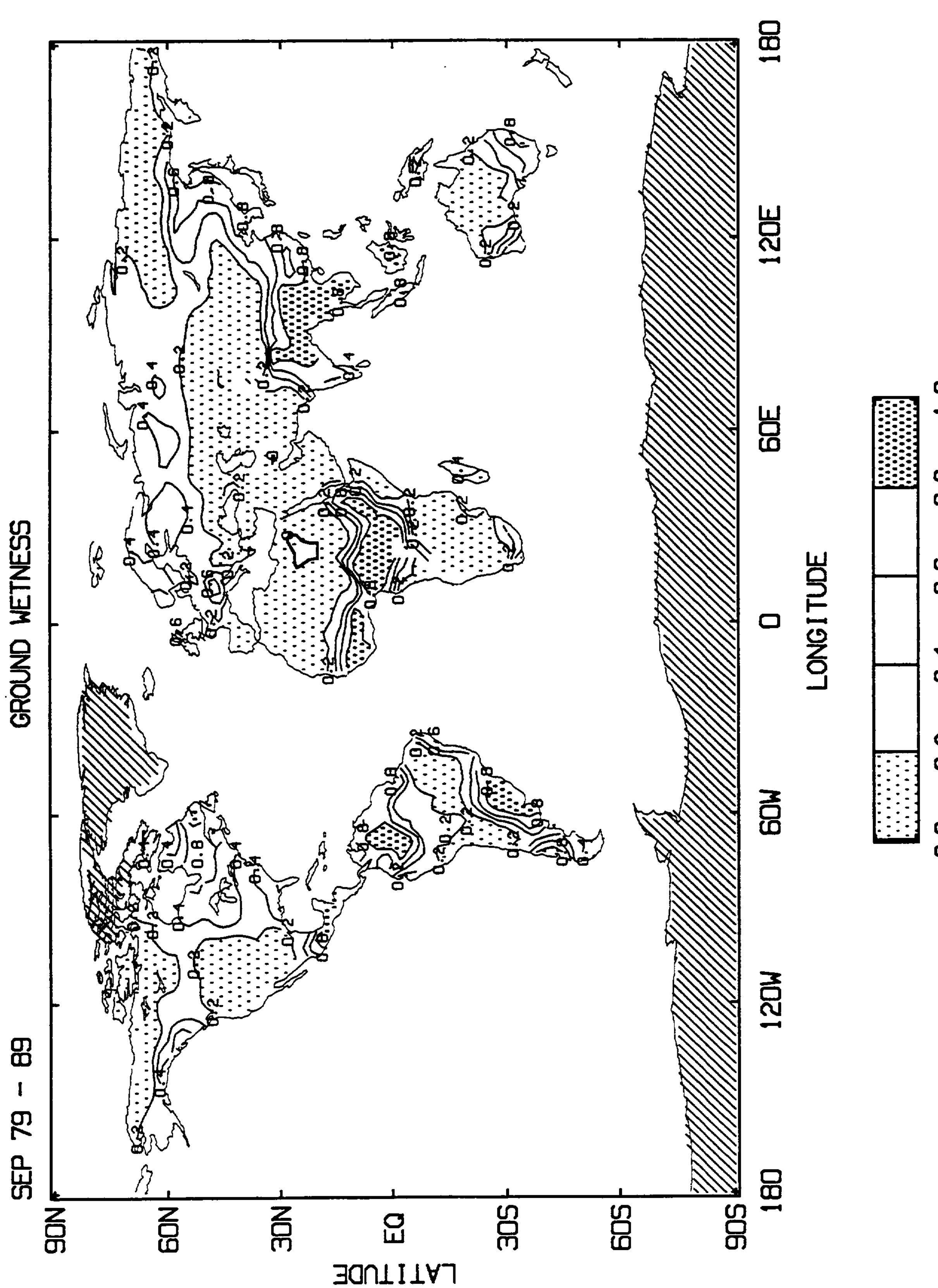
SEPTEMBER


SEP 79 - 89
GROUND WETNESS
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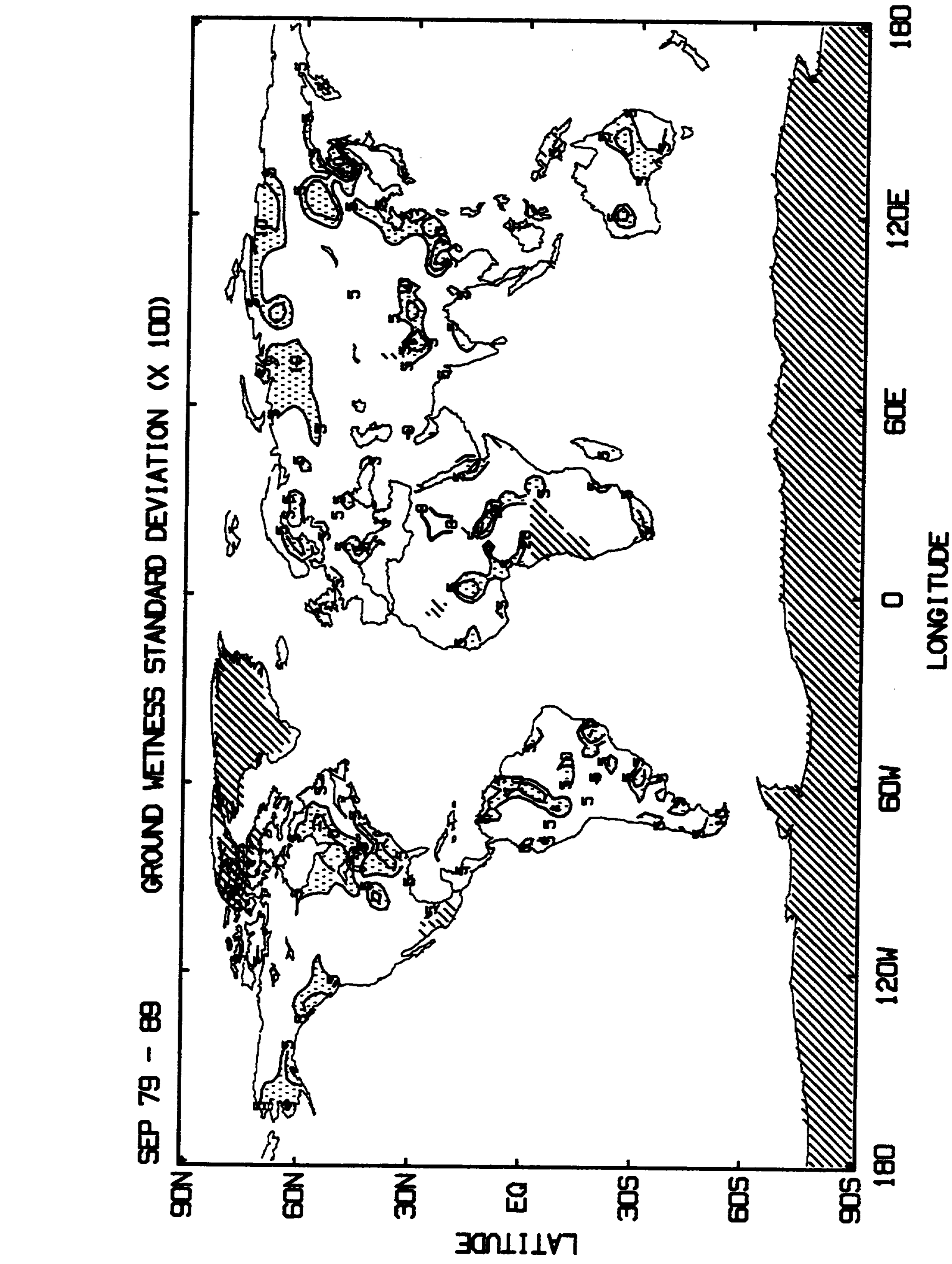
SEP 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
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LONGITUDE
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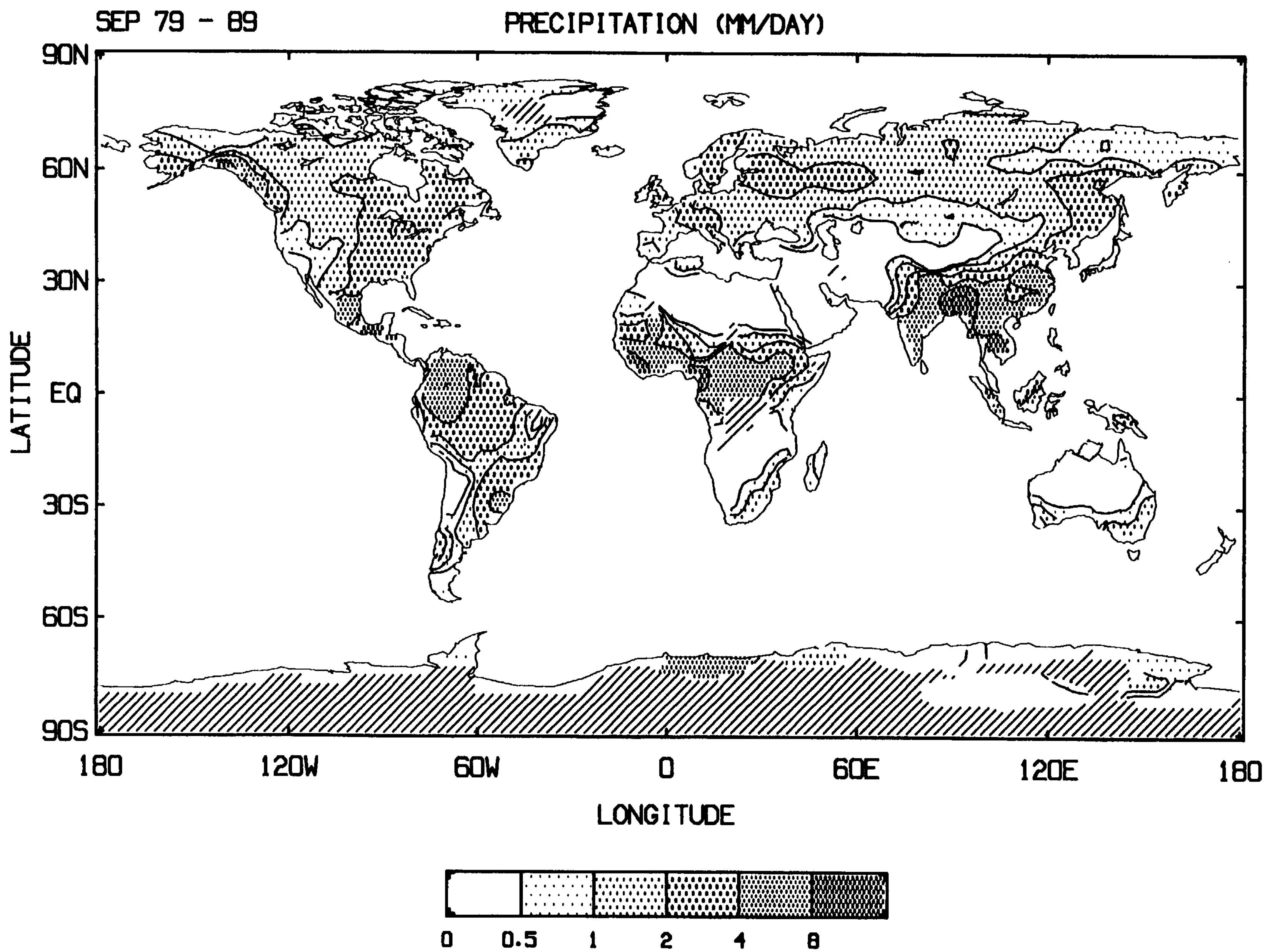
SEP 79 - 89
PRECIPITATION (MM/DAY)
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EQ
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60E
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LONGITUDE
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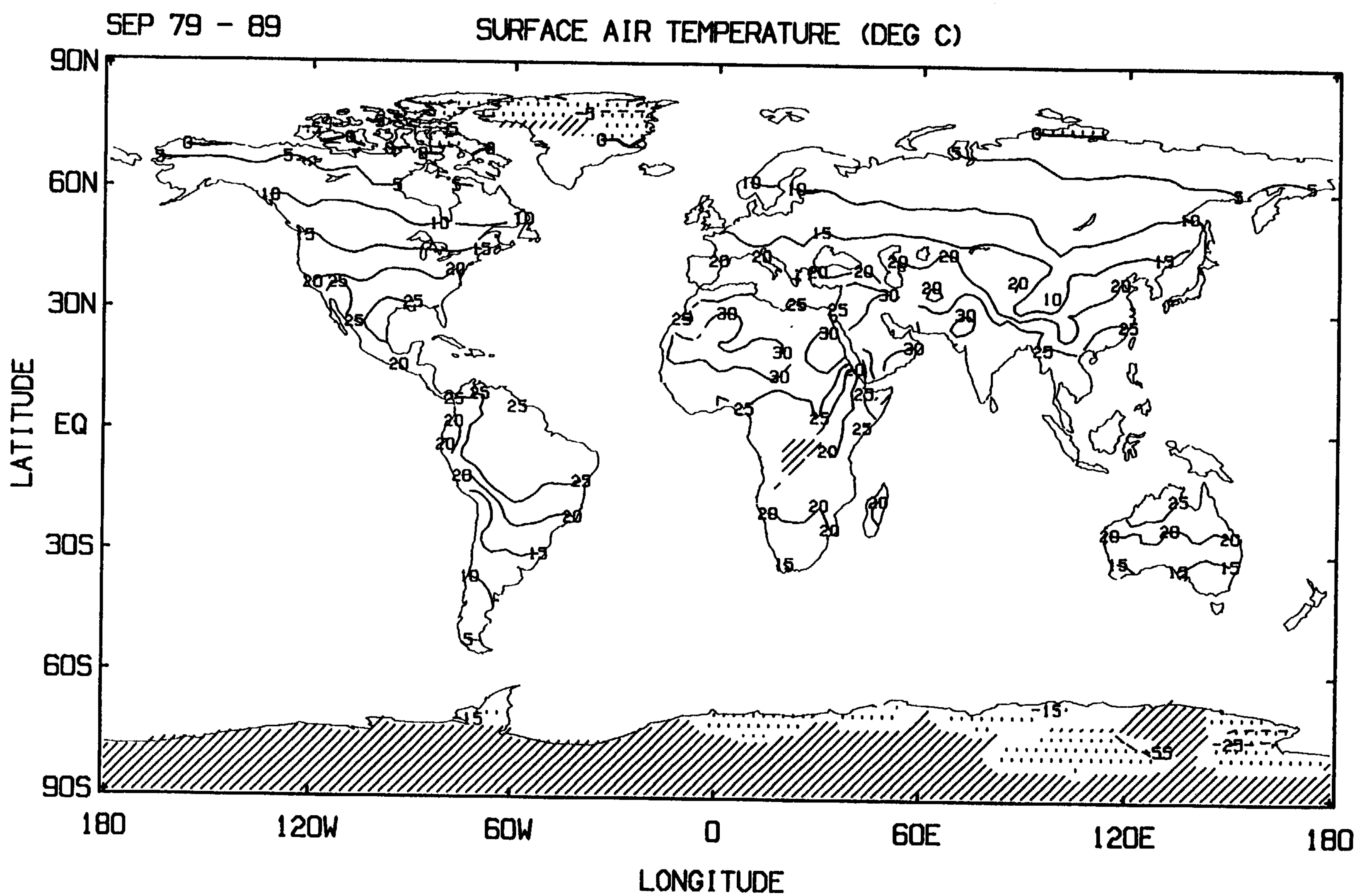
SEP 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
90N
60N
30N
EQ
30S
60S
90S
LATITUDE
180
120W
60W
0
60E
120E
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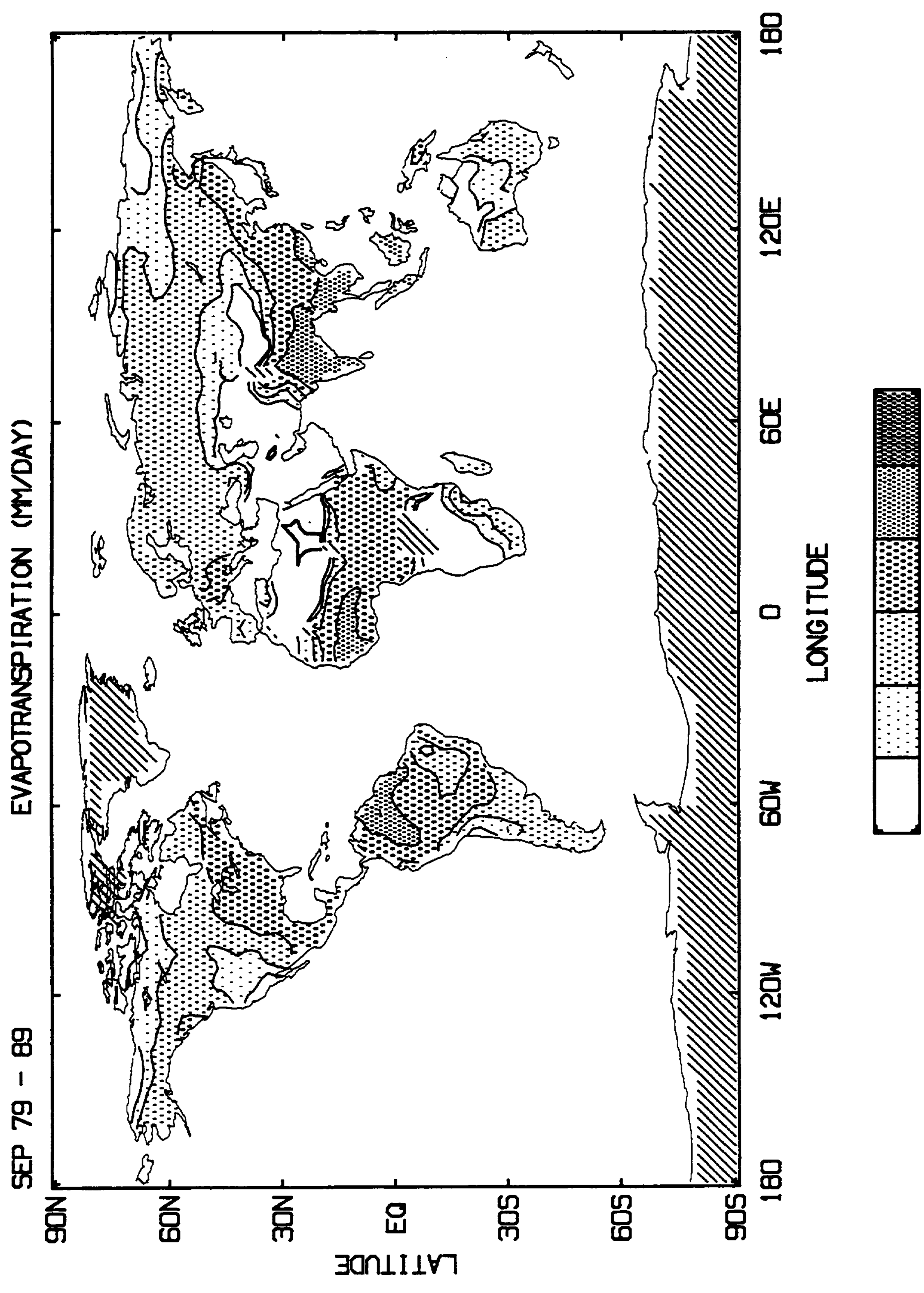
LONGITUDE


SEP 79 - 89
EVAPOTRANSPIRATION (MM/DAY)
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30N
EQ
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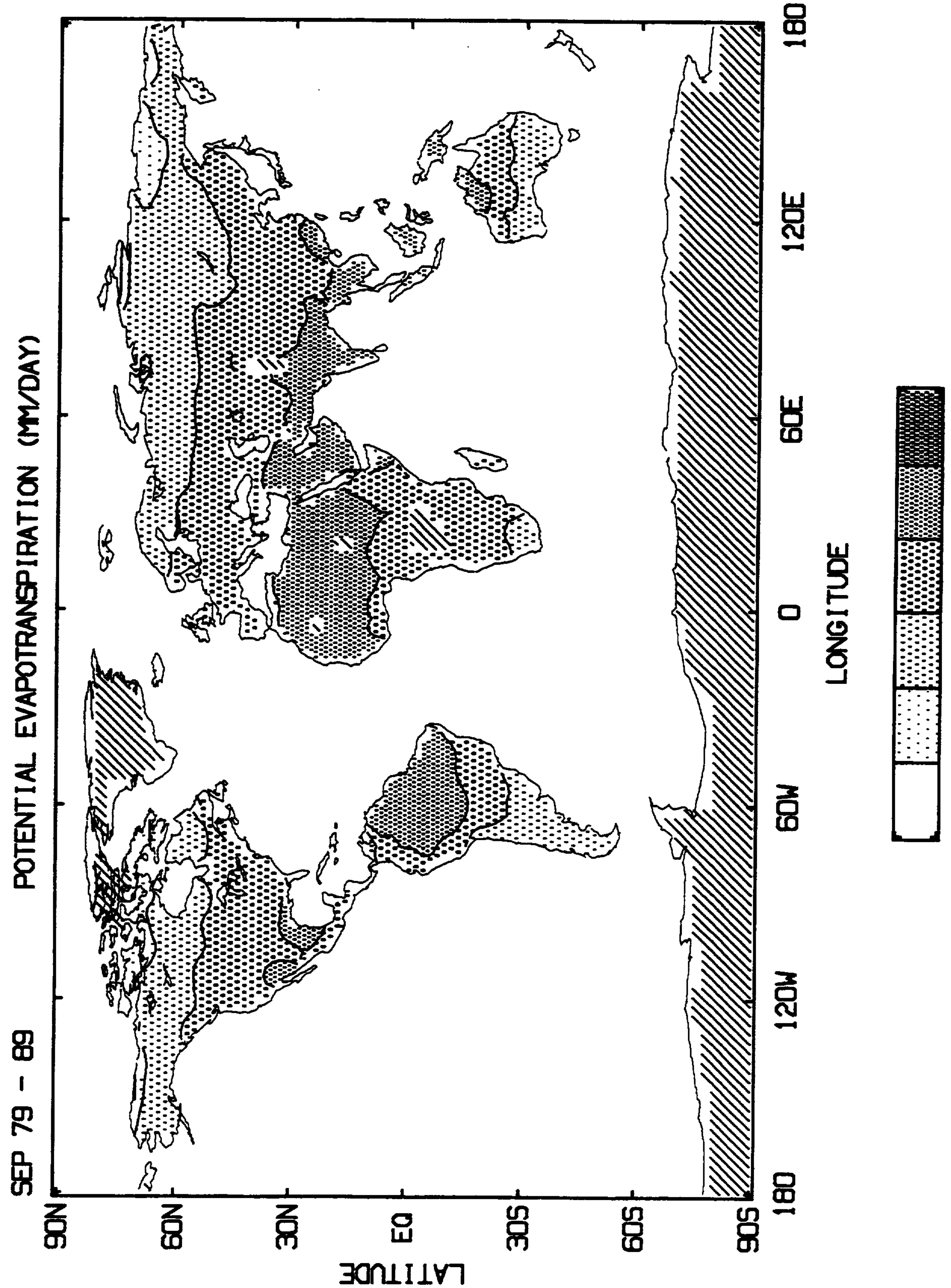
SEP 79 - 89
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)
90N
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EQ
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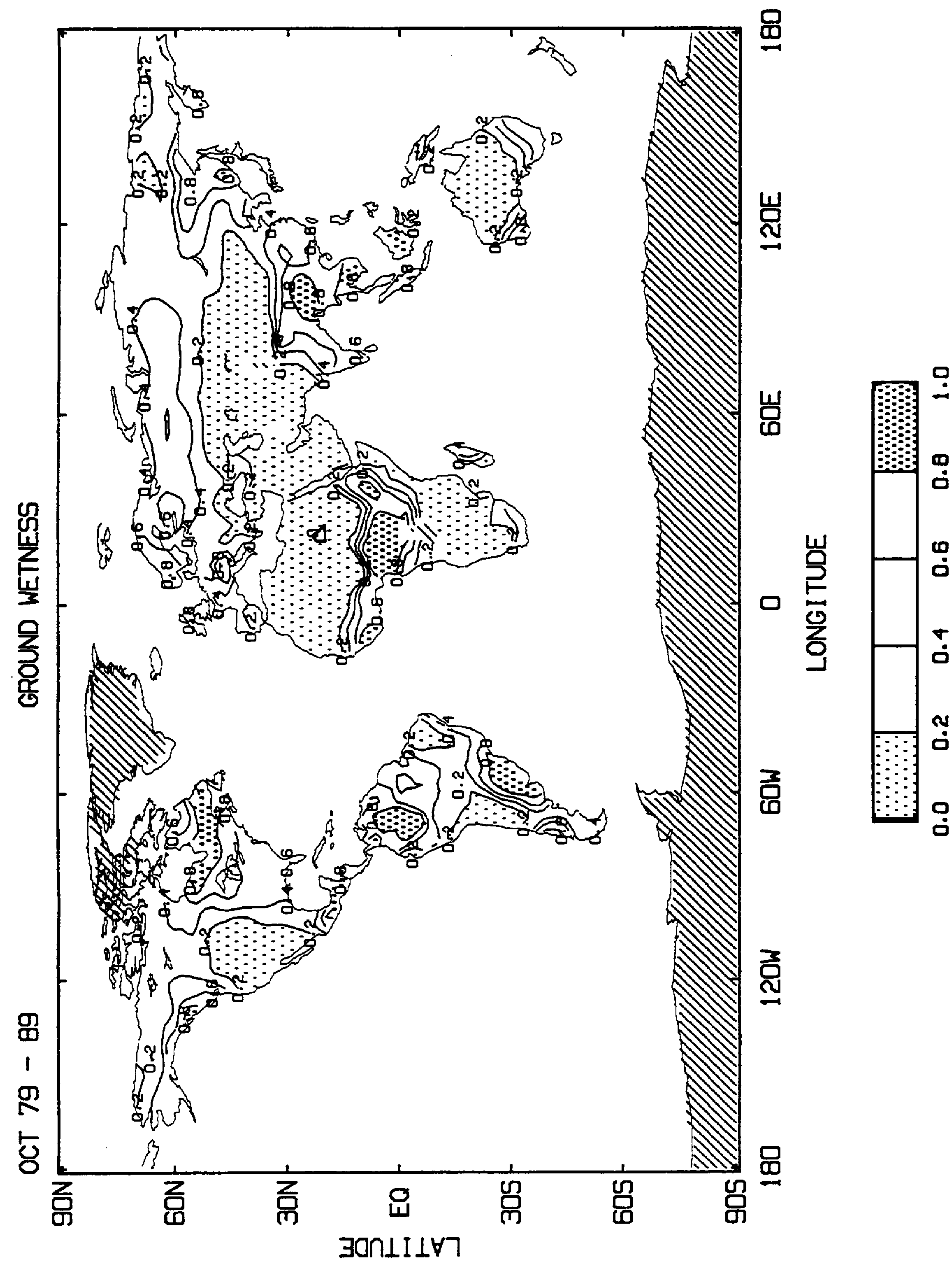
OCTOBER



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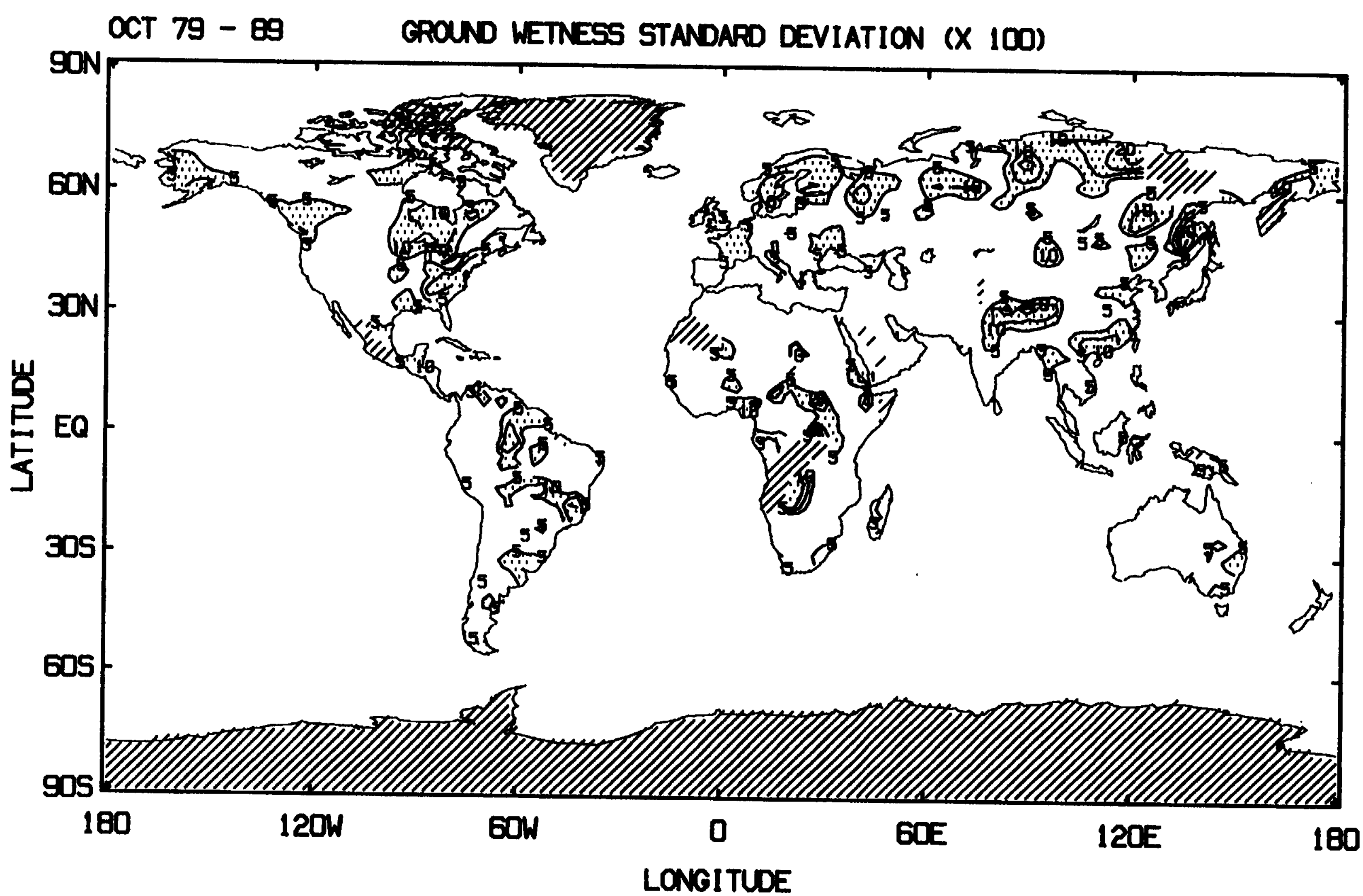
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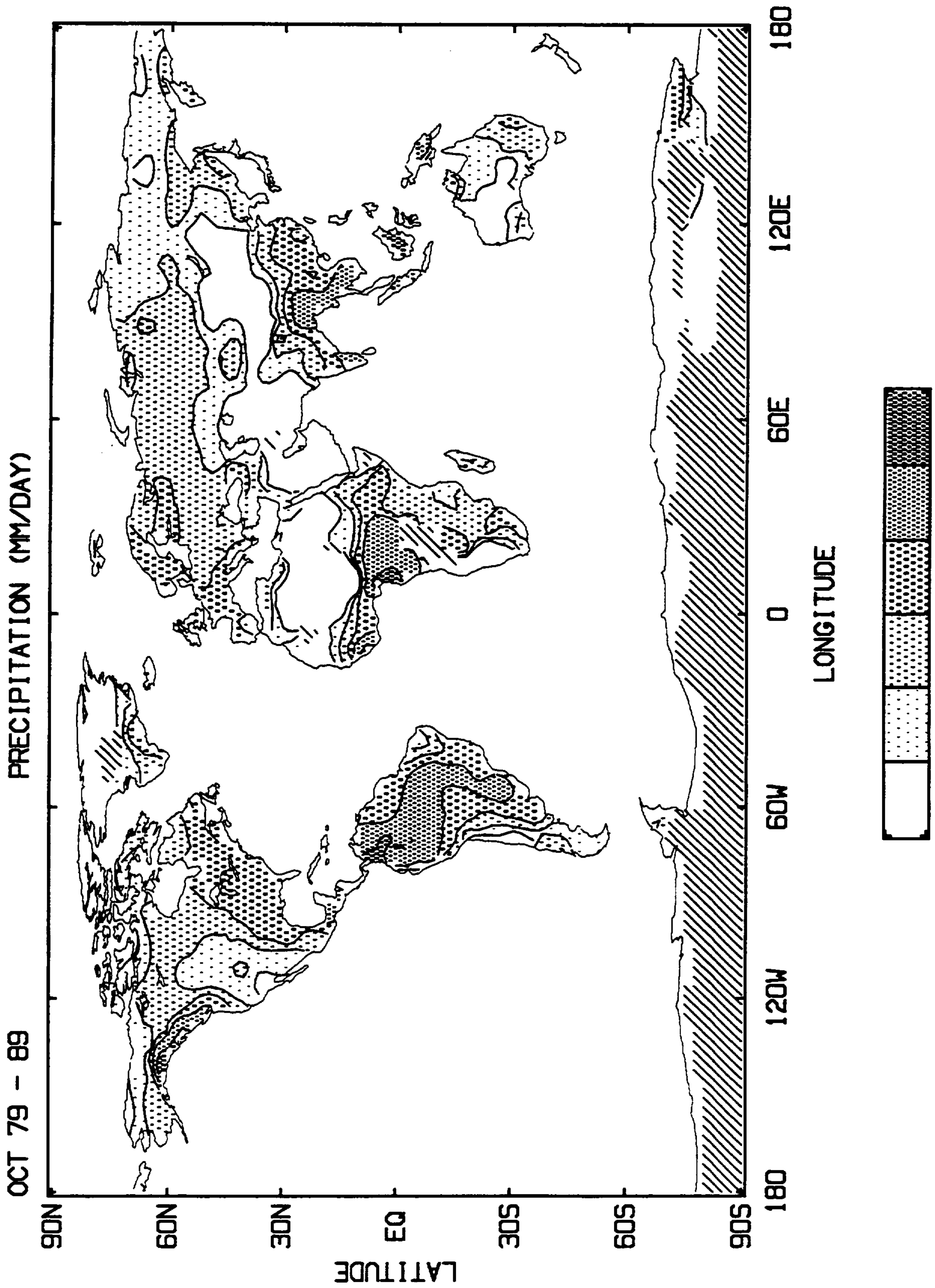
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PRECIPITATION (MM/DAY)
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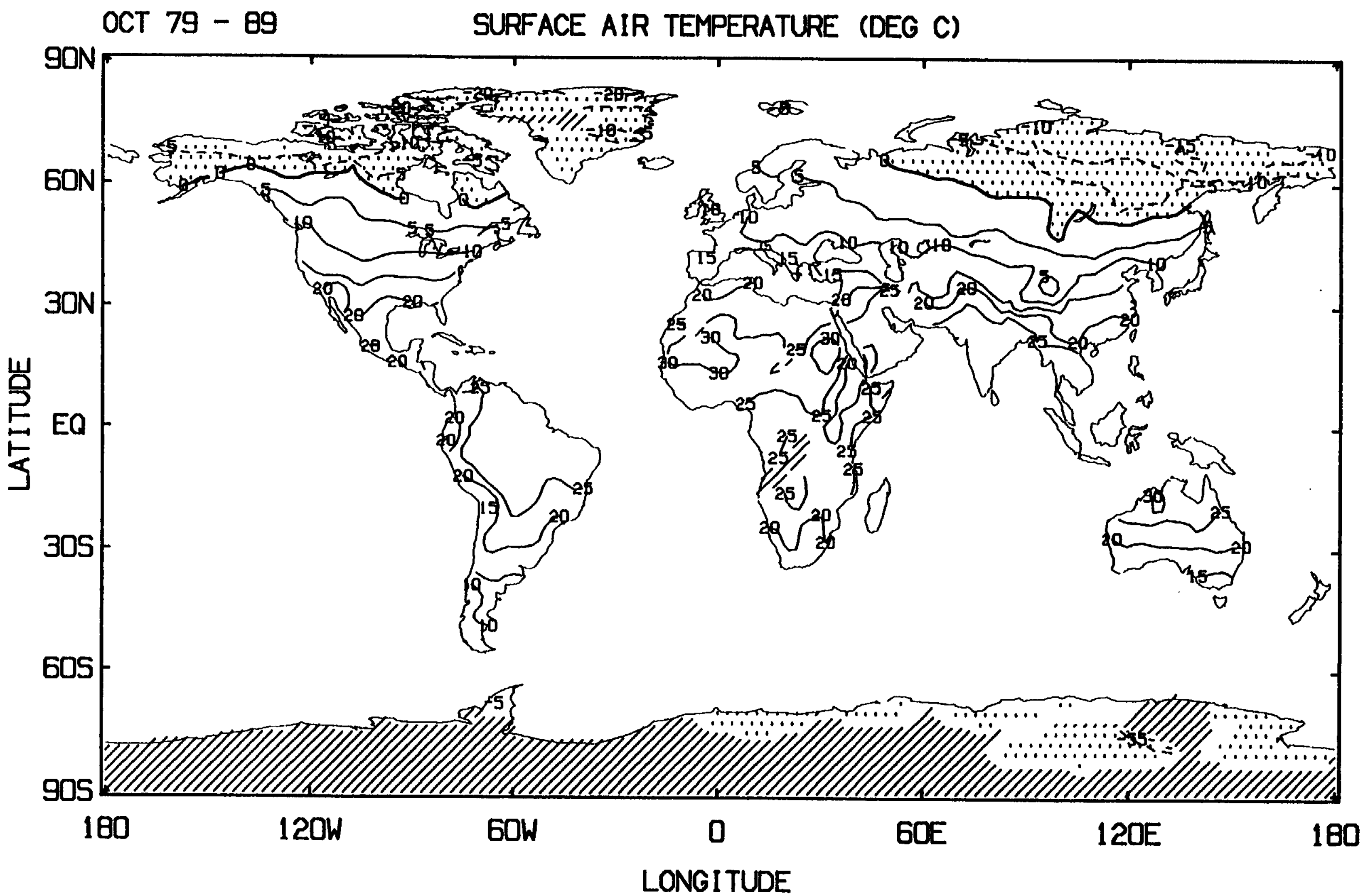
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SURFACE AIR TEMPERATURE (DEG C)
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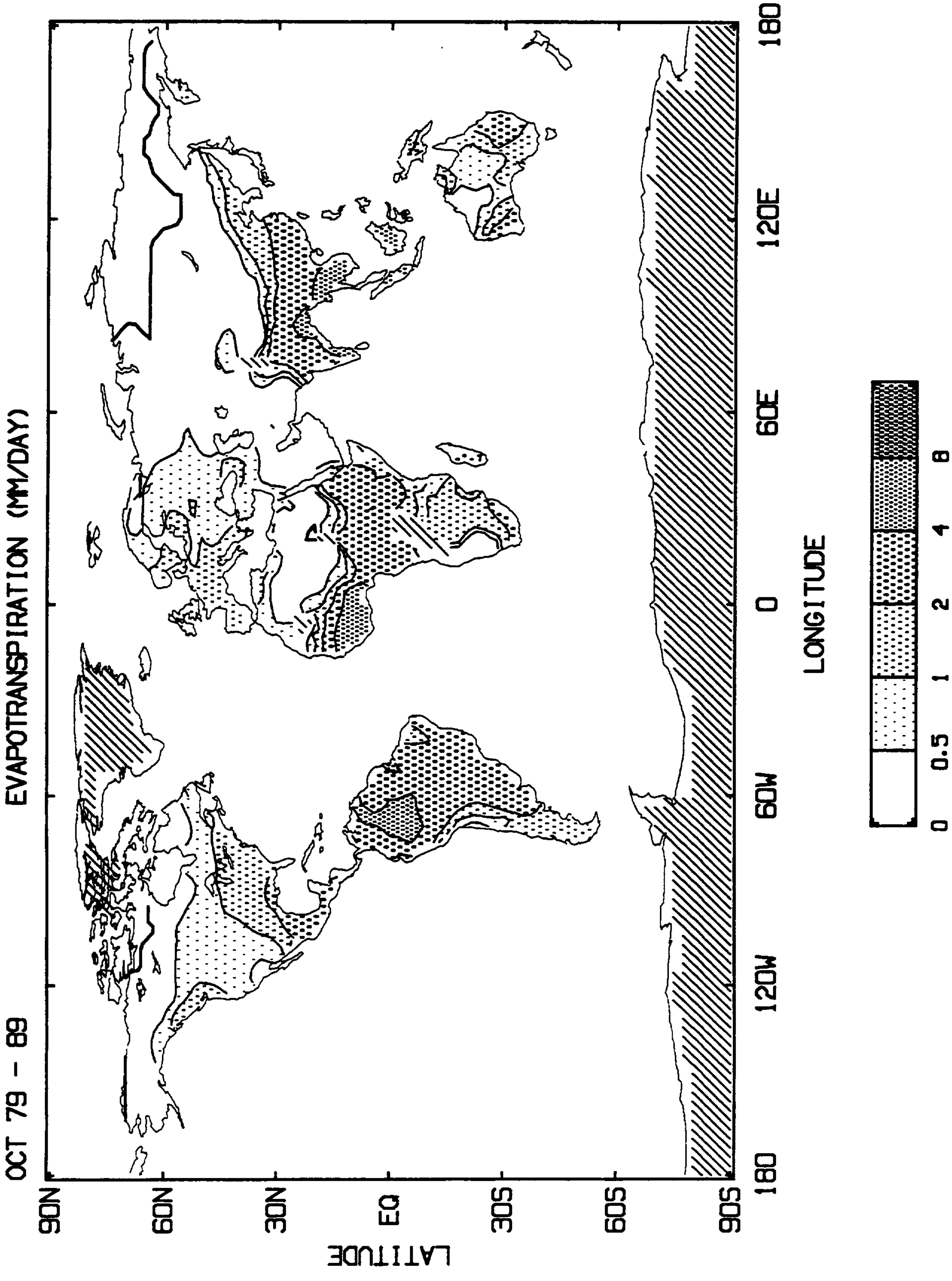
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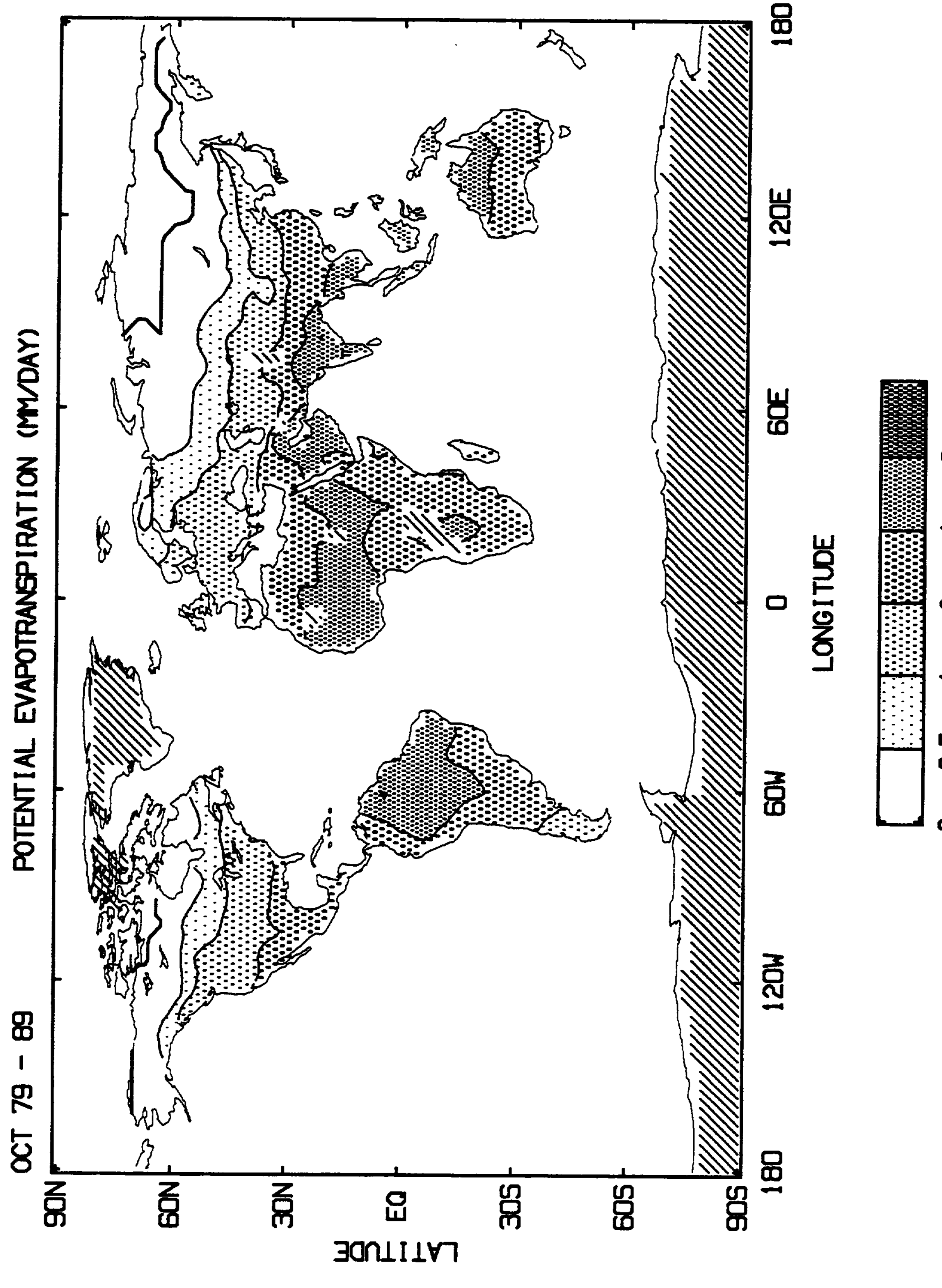

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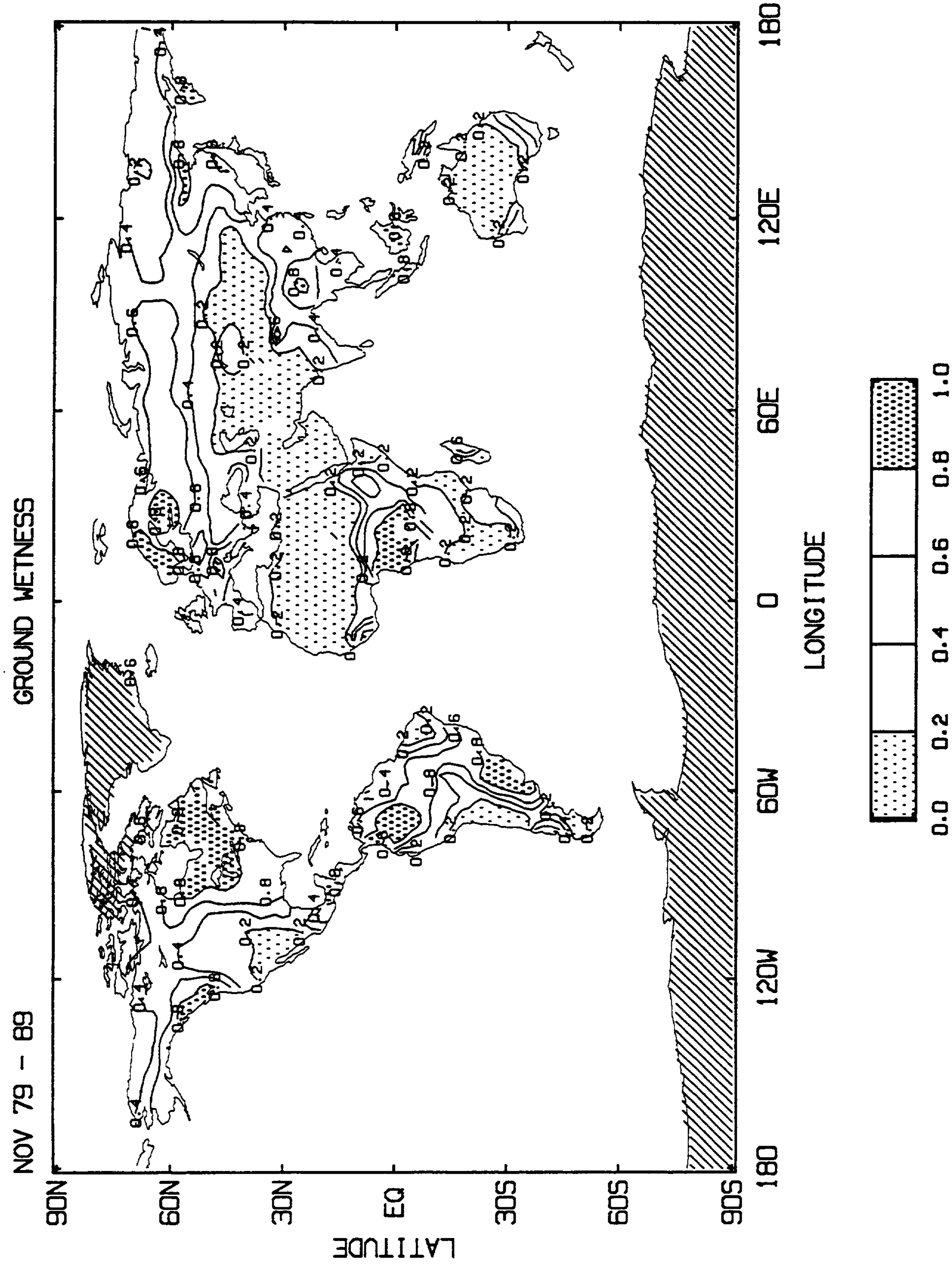

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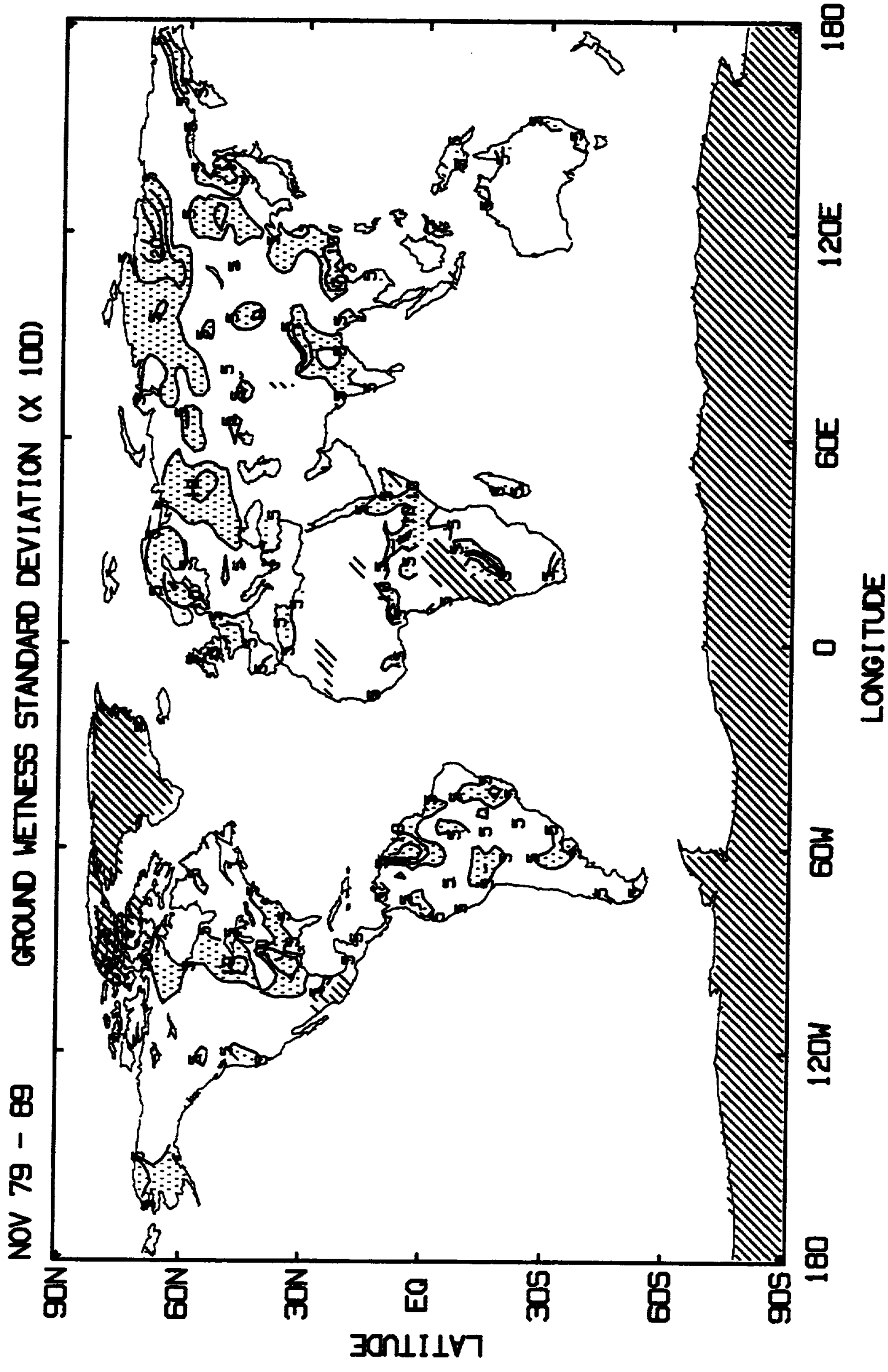
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GROUND WETNESS STANDARD DEVIATION (X 100)
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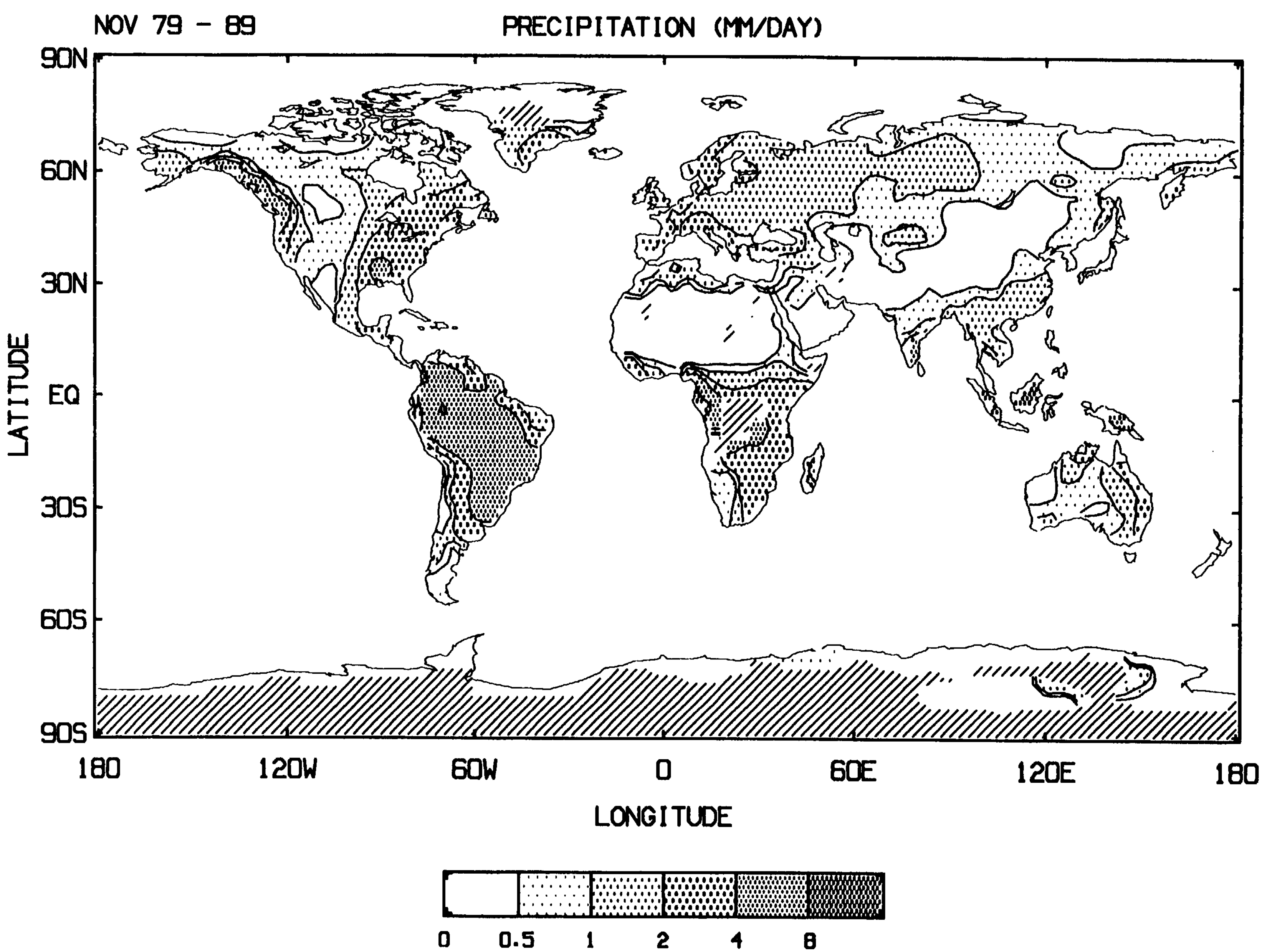
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PRECIPITATION (MM/DAY)
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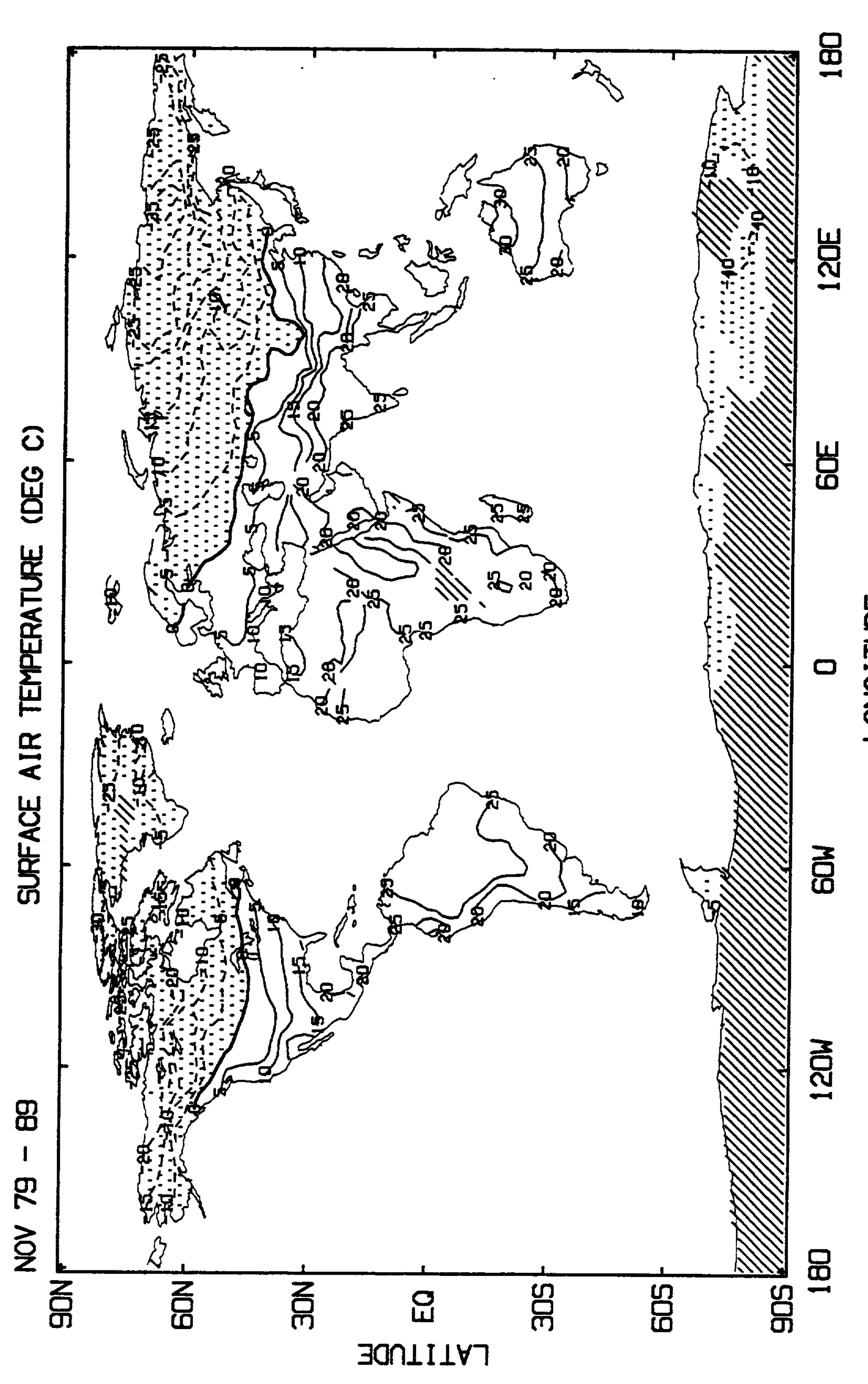
NOV 79 - 89
SURFACE AIR TEMPERATURE (DEG C)
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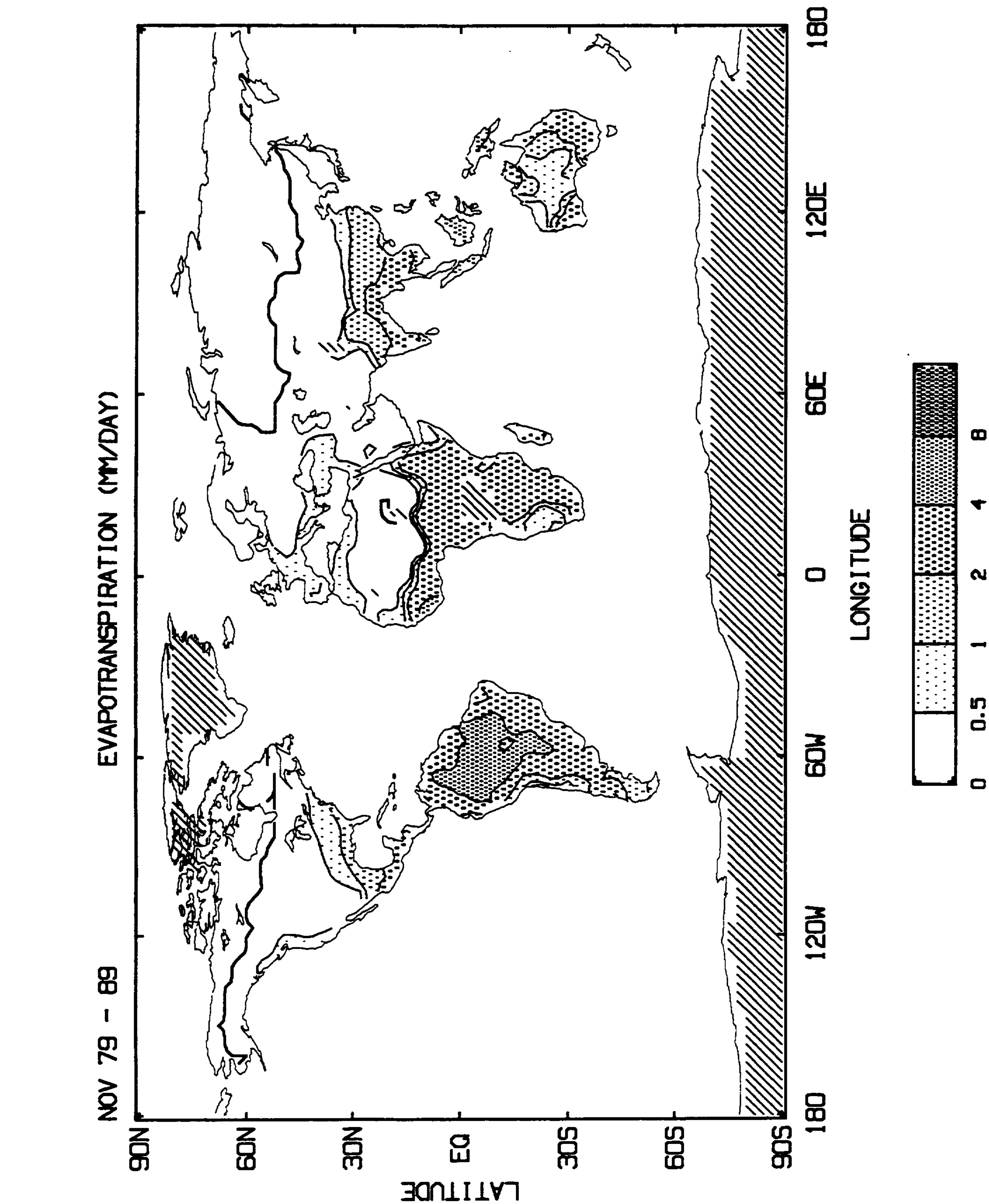
NOV 79 - 89
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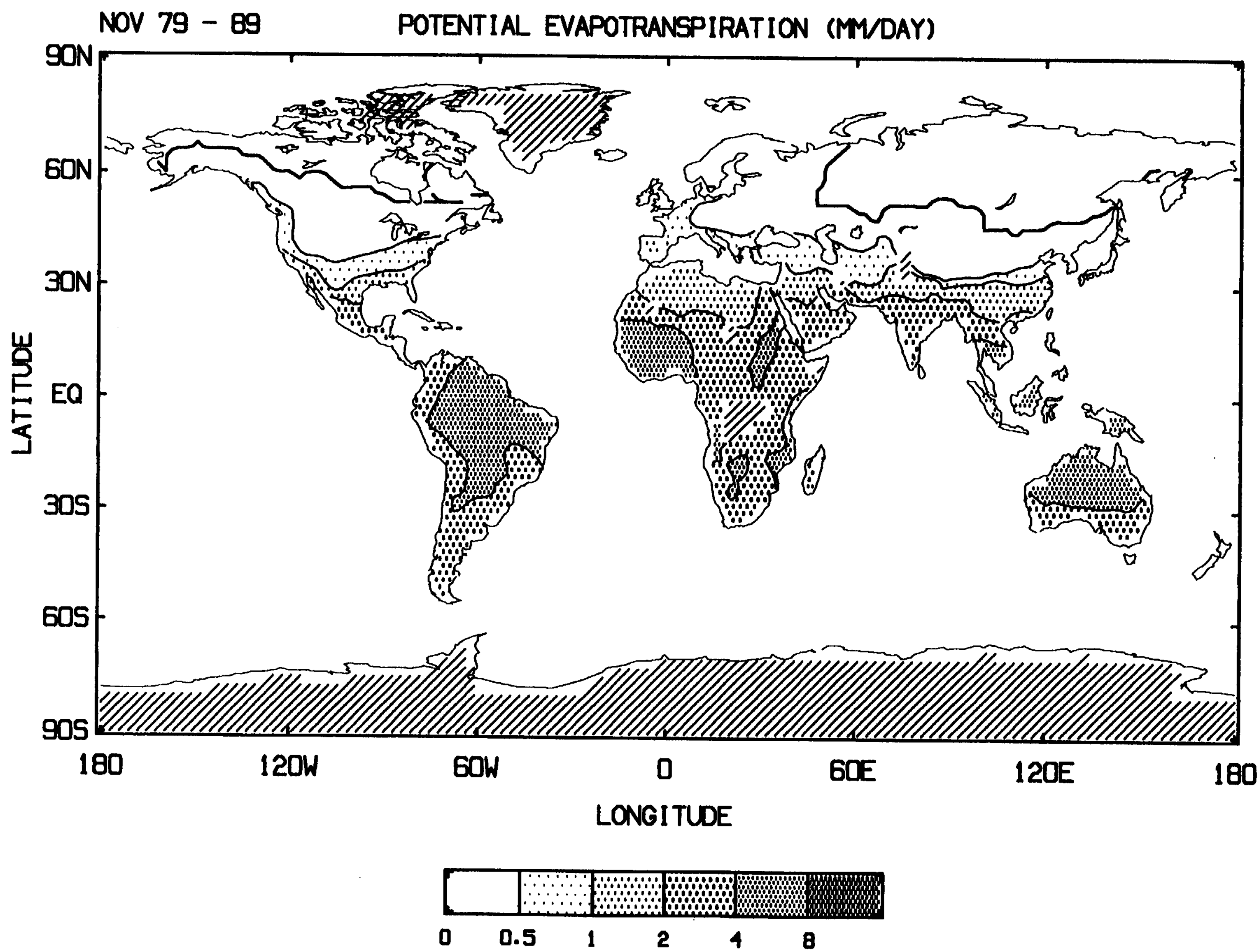
NOV 79 - 89
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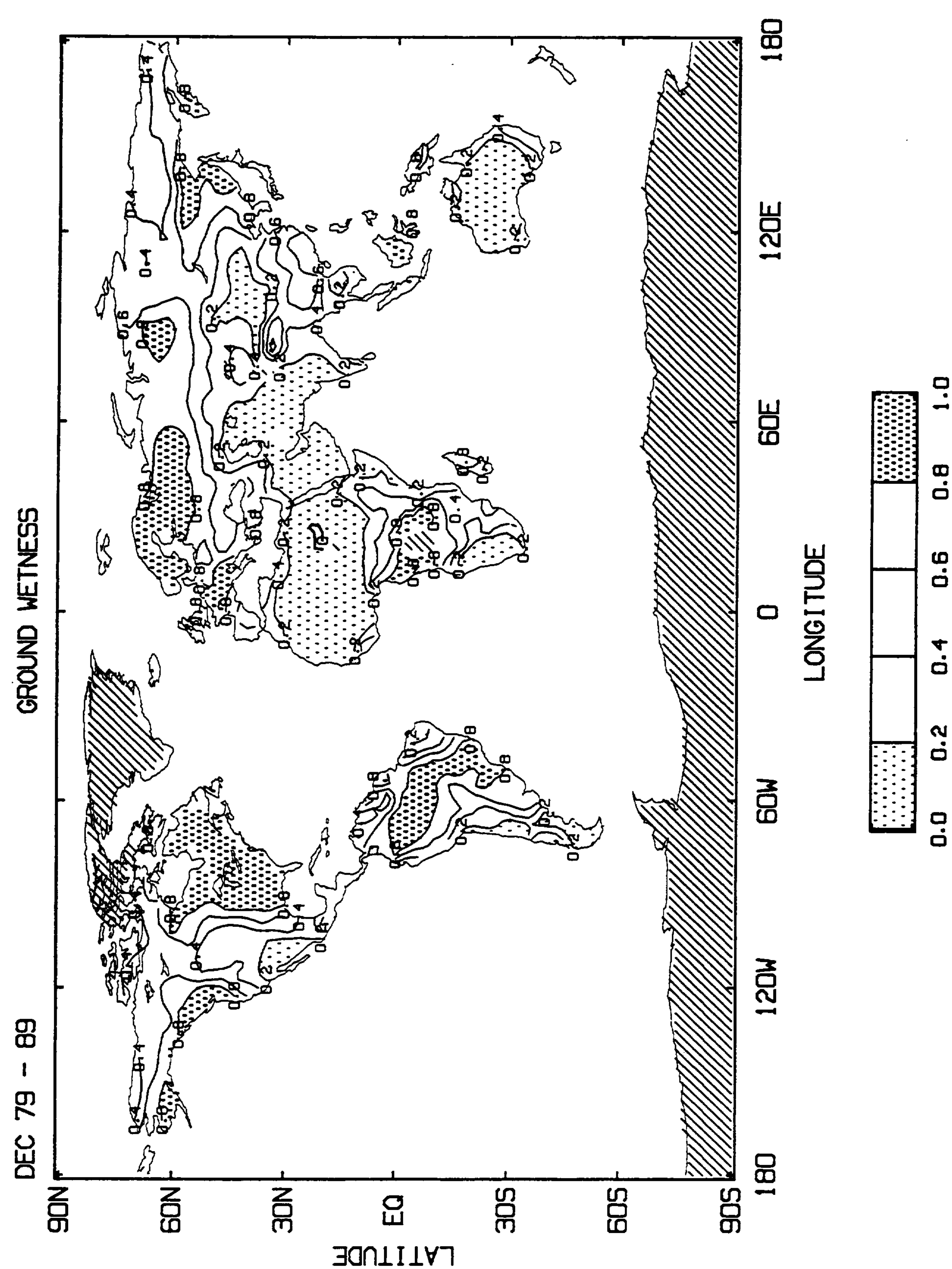
DECEMBER



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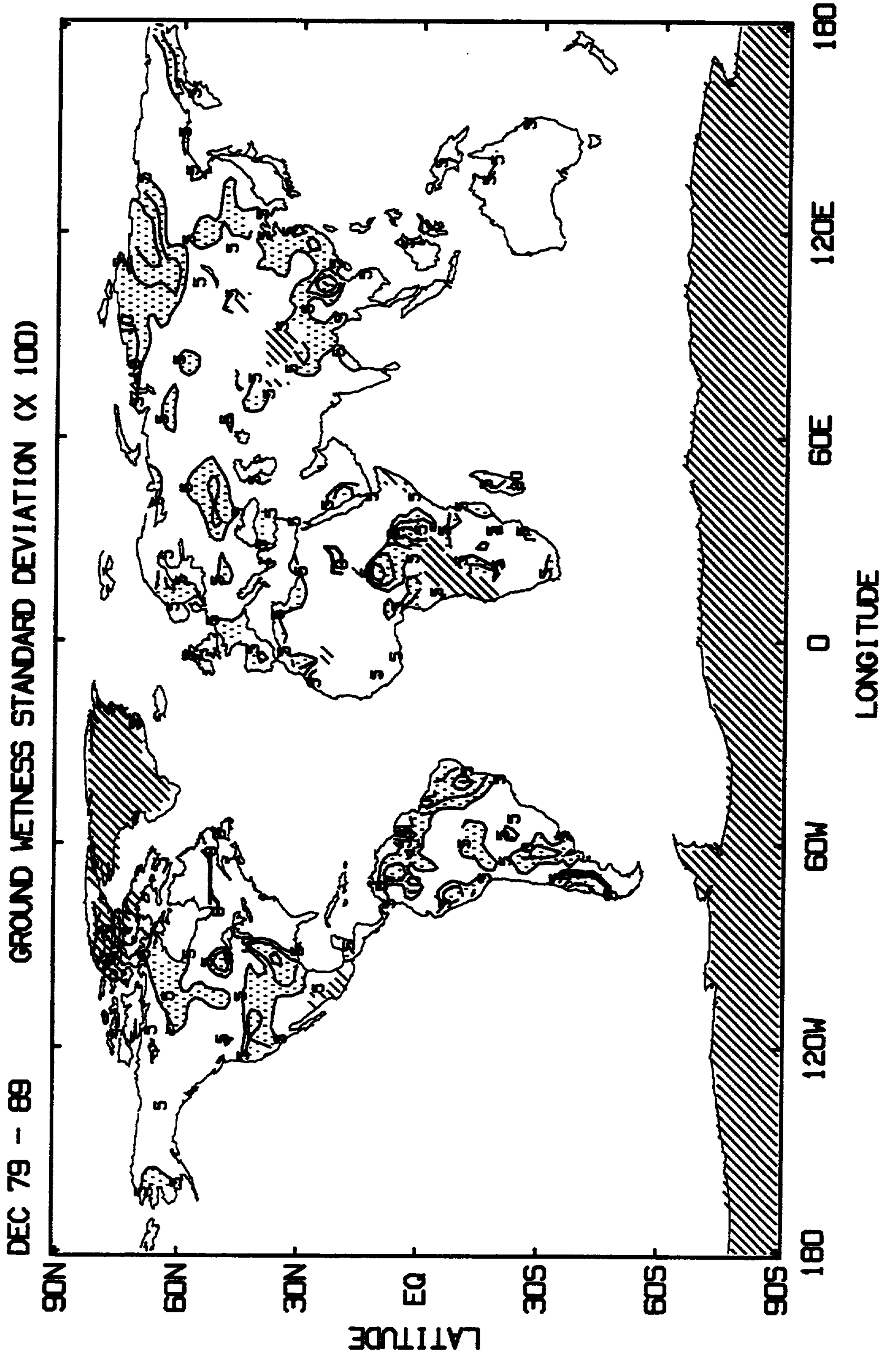

DEC 79 - 89
GROUND WETNESS STANDARD DEVIATION (X 100)
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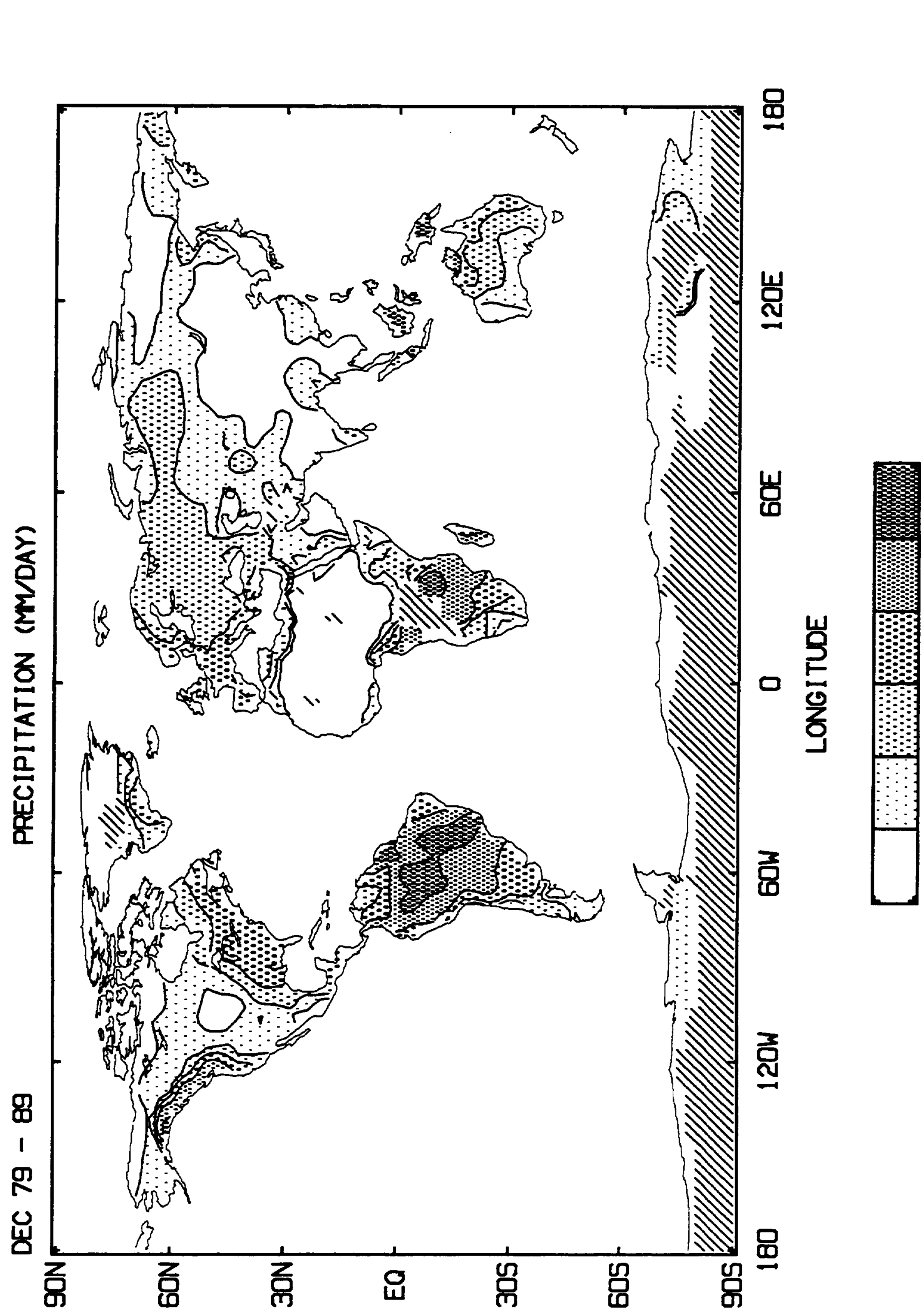

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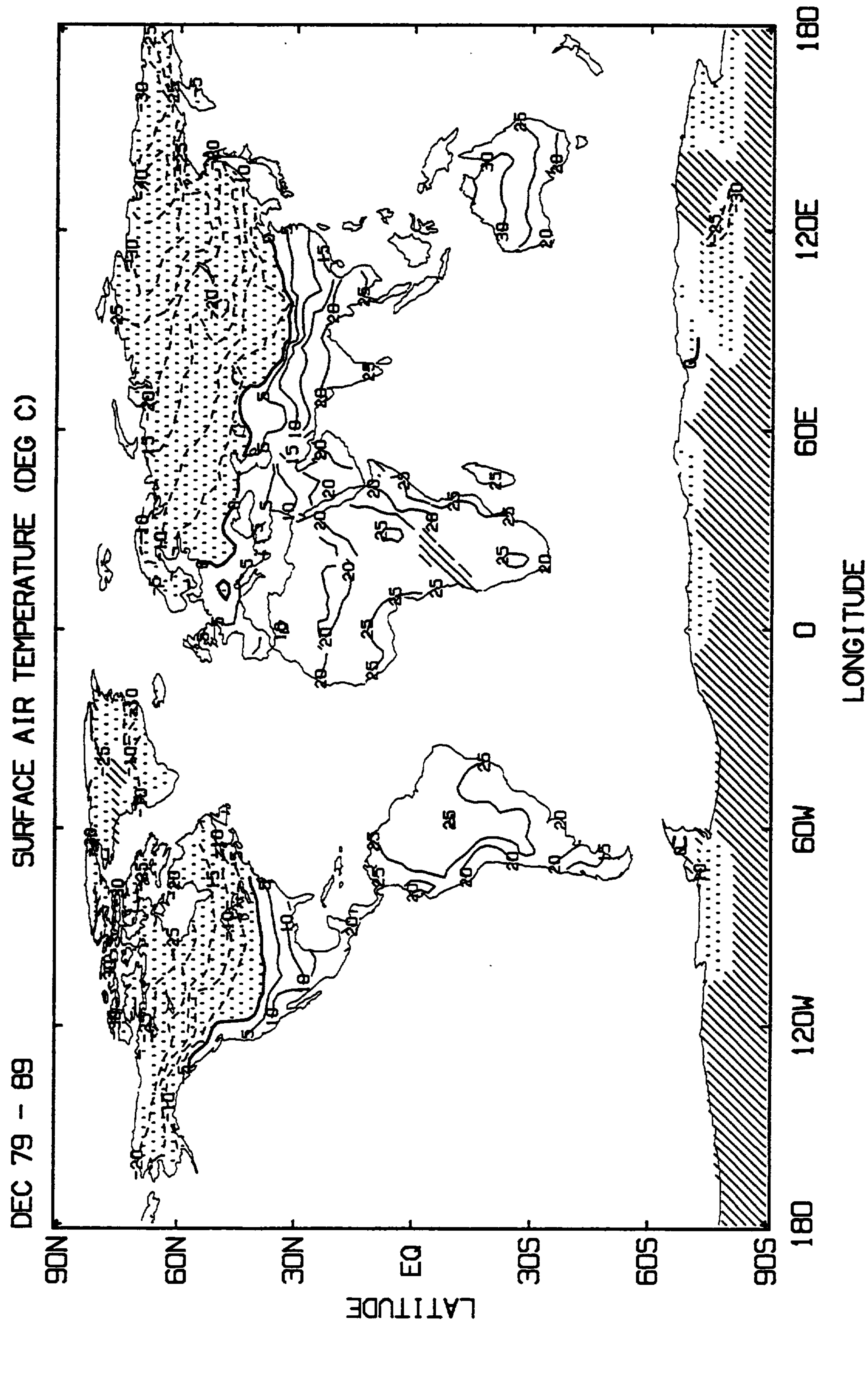
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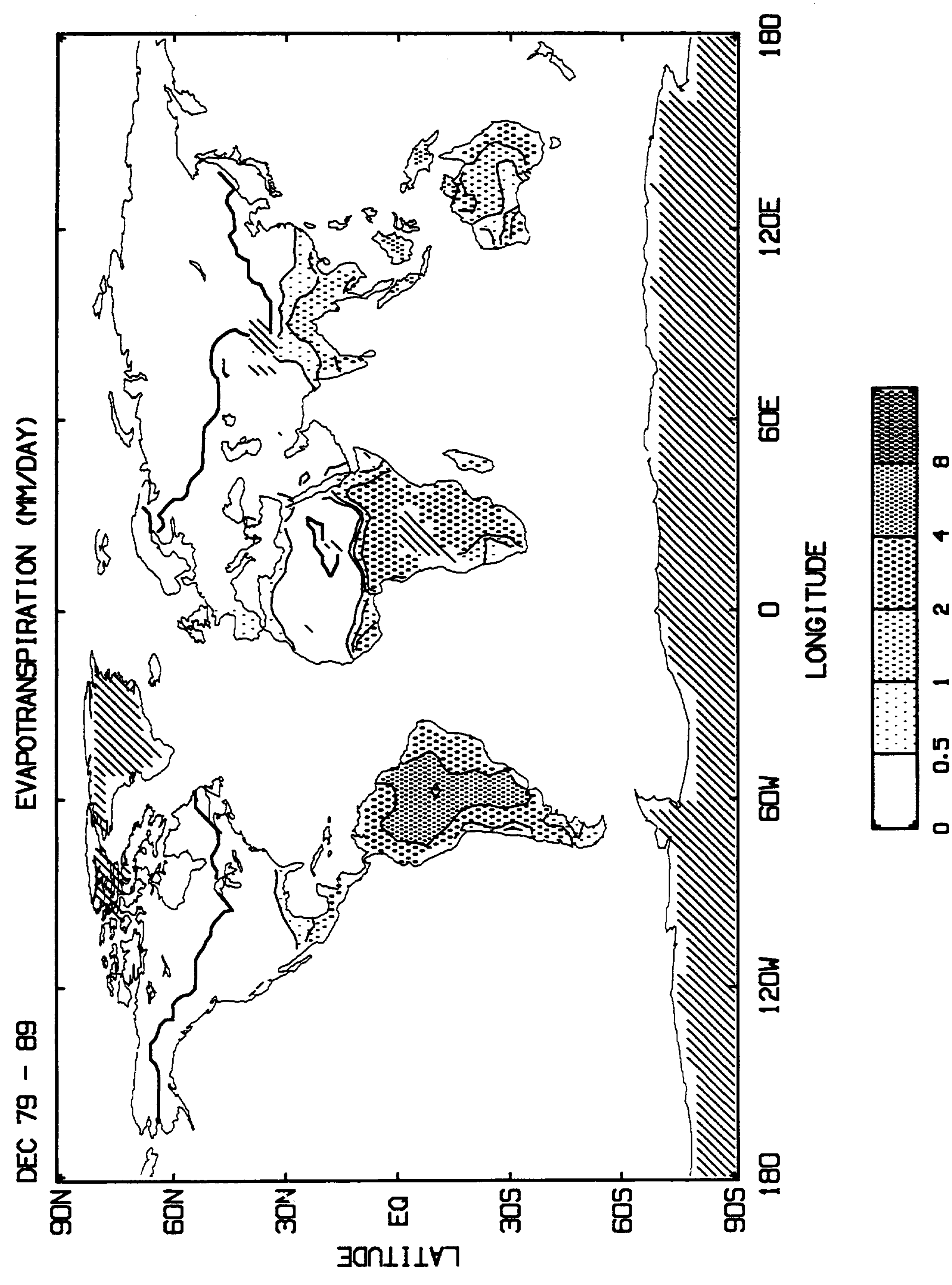
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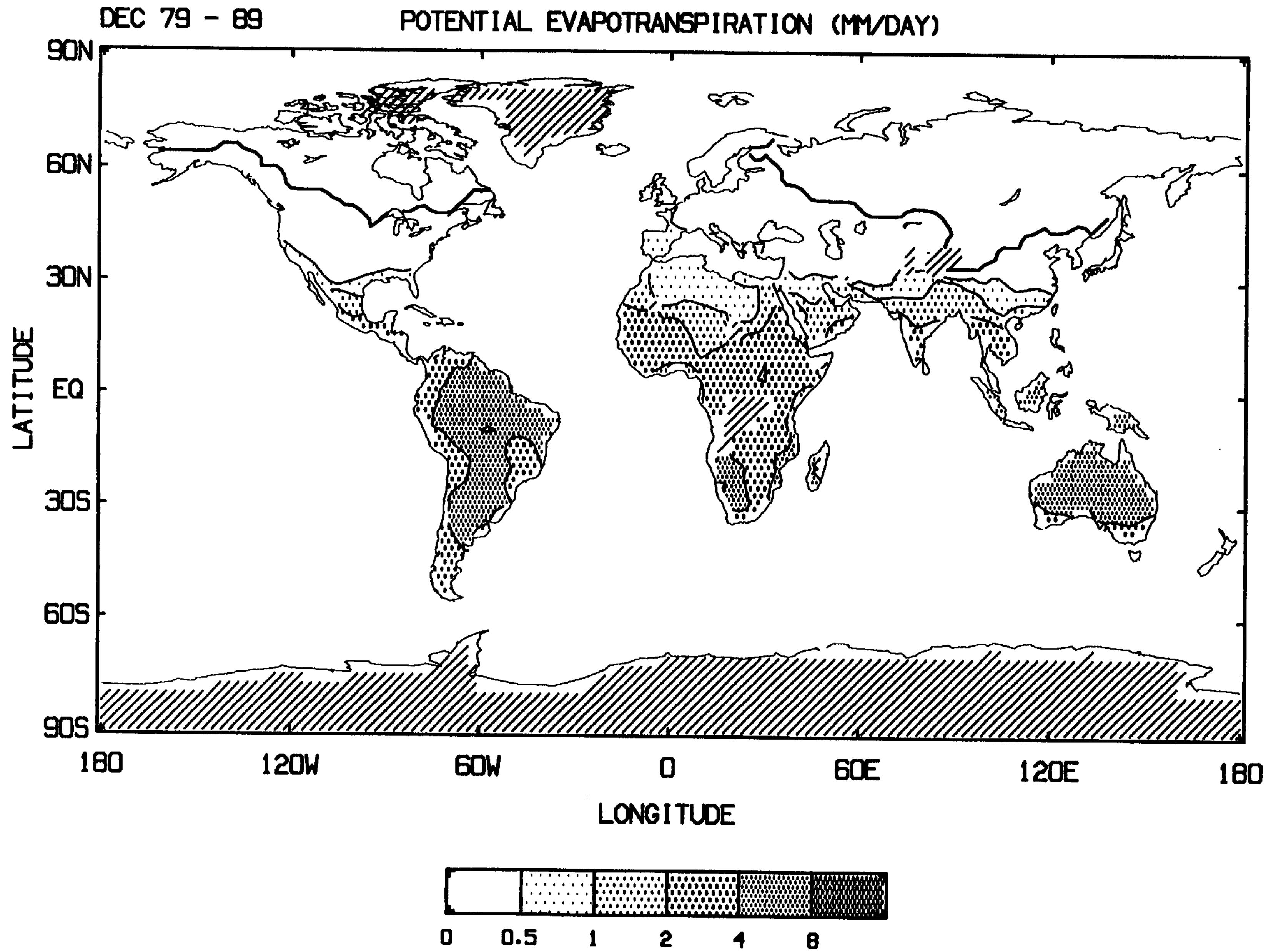
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Goddard Space Flight Center
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13. ABSTRACT *(Maximum 200 words)*

This technical report presents estimated monthly mean global soil moisture distributions for 1979-1989. The soil moisture datasets were prepared as part of the boundary conditions for an atmospheric general circulation model (GEOS-1). Also included are the 11-year averages of monthly mean soil moisture, surface air temperature, monthly total precipitation, evapotranspiration and potential evapotranspiration. The standard deviation of the monthly mean soil moisture is provided as a measure of year-to-year variability.

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