USAFETAC/TN-90/005



# WET-BULB GLOBE TEMPERATURE

## A GLOBAL CLIMATOLOGY

OCTOBER 1990



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USAF
ENVIRONMENTAL TECHNICAL
APPLICATIONS CENTER

Scott Air Force Base, Illinois, 62225-5438

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# PREFACE

This document was prepared in response to requests by AWS/DOOF and 5WW/DNC for a simple wet-bulb globe temperature (WBGT) planning climatology for the entire globe. After determining that the charts in a document prepared by the Gulf Weather Corporation for the U.S. Army Research Institute of Environmental Medicine (*Global Climatology for the Wet Bulb Globe Temperature (WBGT) Heat Stress Index*) would fill AWS and 5WW needs, the WBGT charts were extracted, traced in black and white, and reproduced here.

The charts represent *climatology*, and should therefore be used for planning only. At this writing, USAFETAC was developing a more precise method for producing WBGT climatologies for specific locations and times. For more information, contact USAFETAC/ECE, Scott AFB IL 62225-5438, DSN 576-3641.

# CONTENTS

# THE WET-BULB GLOBE TEMPERATURE (WBGT) HEAT STRESS INDEX

**WBGT Explained.** According to AFP 160-1, Prevention, Treatment and Control of Heat Injury, July 1980, the WBGT (wet-bulb globe temperature) is the most practical heat stress index characterizing the effect of a heat stress environment on the individual. WBGT was developed because the dry-bulb temperature alone does not provide a realistic guide to the effects of heat, inasmuch as it does not take humidity and heat radiation into consideration. WBGT is so-called because two of its input variables are wet-bulb temperature and a "black-globe" temperature; the third variable is the shielded dry-bulb temperature. The wet-bulb temperature used in computing WBGT is taken from a stationary thermometer exposed to the sun and prevailing wind. The correct exposure of the three thermometers used to obtain these quantities is shown on the next page.

**WBGT Responsibilities.** The computation and dissemination of WBGT heat stress index information is not an Air Weather Service responsibility; all such information is determined and provided by medical personnel. AWS does, however, provide WBGT climatology.

**Computing the WBGT Index.** WBGT is computed by adding 70% of the wet-bulb temperature, 20% of the black-globe temperature, and 10% of the dry-bulb temperature. The formula is:

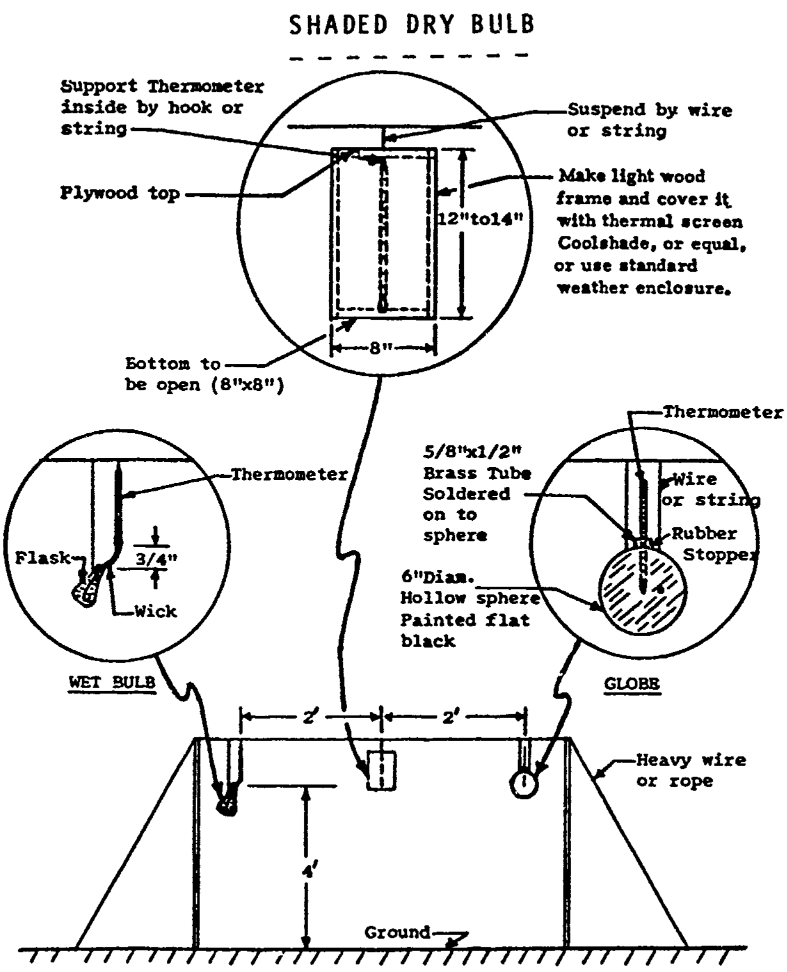
$$WBGT = 0.7\,WB + 0.2\,BG + 0.1\,DB$$

Where: WB = wet-bulb temperature
BG = black-globe temperature
DB = dry-bulb temperature

**The Effects of WBGT.** AFP 160-1 provides detailed descriptions of how WBGT affects human performance and tells how to deal with those effects. The following table (extracted from FM 21-10) provides a guide to WBGT effects; it should be noted, however, that heat casualties have been observed at WBGTs of 75° F, and even lower. AFM 105-4, *Weather Support for Army Tactical Operations*, gives WBGTs of more than 85° F (29.4°C) as a "critical meteorological value " for Army support.

| WBGT ( °F) | Water Intake (quarts/hour) | Work/rest cycle (minutes) |
|---|---|---|
| 78-81.9 | at least 1/2 | 50/10 |
| 82-84.9 | at least 1/2 | 50/10 |
| 85-87.9 | at least 1 | 45/15 |
| 88-89.9 | at least 1 1/2 | 30/30 |
| 90 & above | more than 2 | 20/40 |

**Determining "Black-Globe Temperature.** The "black-globe" temperature (one of the three WBGT inputs) is obtained from a thermometer with its bulb at the center of a 6-inch copper sphere painted flat black, with walls about .022 inches thick--toilet tank floats normally do very well. The thermometer in the globe is exposed to the air and sun for at least 20 minutes to stabilize. When it does, the temperature "integrates the cooling or heating effects of air movement with the radiant heat gain or loss" (AFP 160-1). The Army and Navy have developed portable WBGT kits for use in the field; NSNs are: Army: NSN 6665-00-159-2218, Navy: NSN 2H-6685-01-055-5298. The illustration on the next page (from AFP 160-1) shows how all three thermometers are exposed.




**THE WBGT FIELD THERMOMETER SET-UP.**

# THE WBGT CHARTS EXPLAINED

**Data Description.** Global average maximum WBGT climatology is given as temperature isolines (degrees F) on charts for North and South America, Africa, and Asia, for January, April, July, and October. All data is from *Global Climatology for the Wet Bulb Globe Temperature (WBGT) Heat Stress Index*, U.S. Army Research Institute of Environmental Medicine, Natick, MA, 1989. WBGT data was computed from average maximum dry-bulb and wet-bulb temperatures from the World Weather Guide. Black-globe temperatures were derived using a model developed by the U.S. Army Research Institute of Environmental Medicine; inputs were latitude, longitude, dry-bulb temperature, local time (1500), Julian date, and climate type. Wind speed was assumed to be 3 meters/second. Black-globe temperatures were computed at every 5 degrees of latitude. A solar climatology atlas was used to position black-globe temperature maxima in the area of solar shortwave radiation maxima. WBGT values were computed for about 500 stations.

**Chart Areas.** The charts are for three areas of the globe: North and South America, Africa, and Asia. The area of coverage extends only from 60° N to 60° S; WBGT beyond those latitudes does not require discussion.

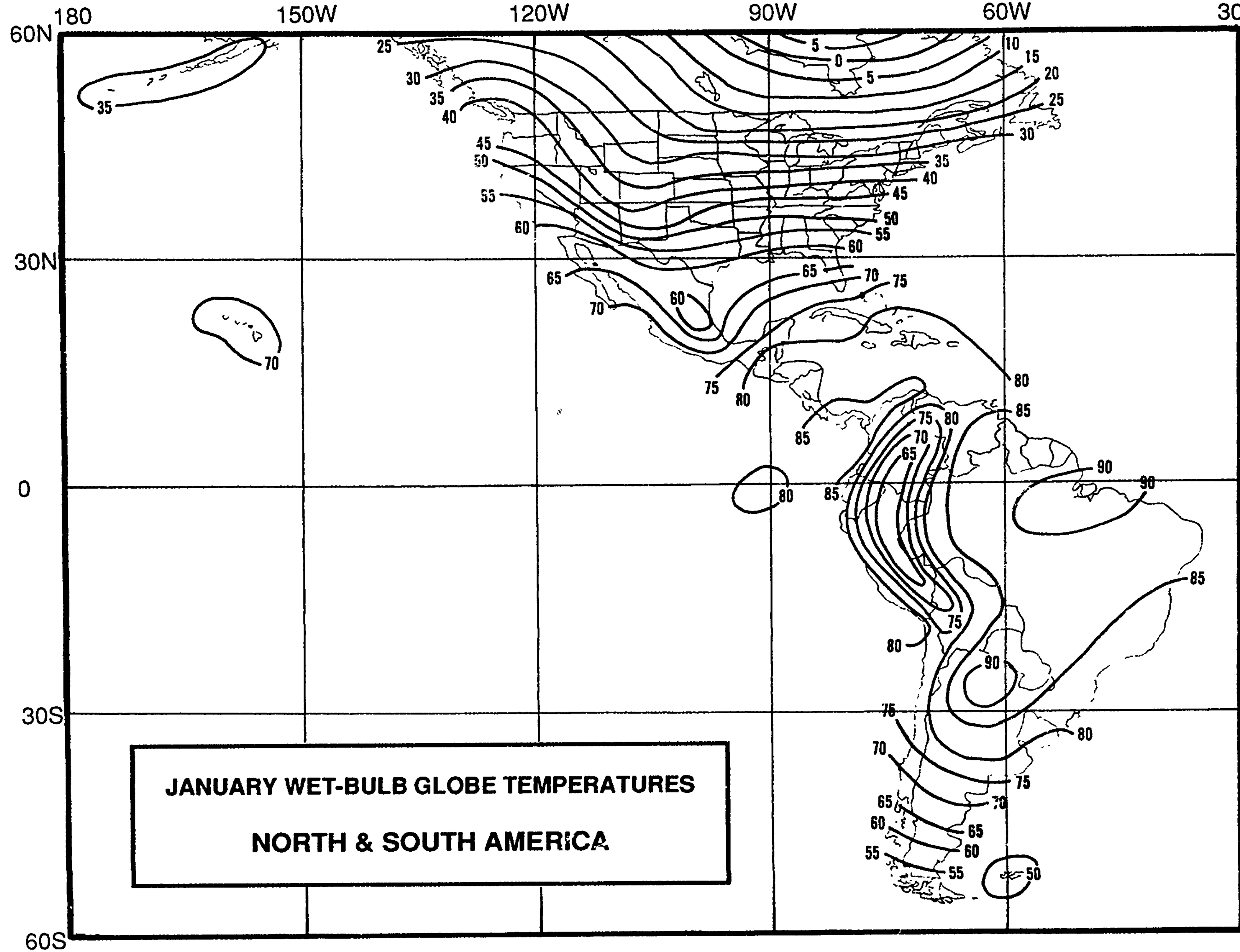
**Seasonal Representation.** The charts are provided for four representative months:

***January***, the coldest month in the northern hemisphere and the hottest month in the southern hemisphere, was chosen to represent northern hemisphere winter and southern hemisphere summer.

***April*** was chosen to represent the transition from winter to summer in the northern hemisphere and vice-versa in the southern hemisphere.

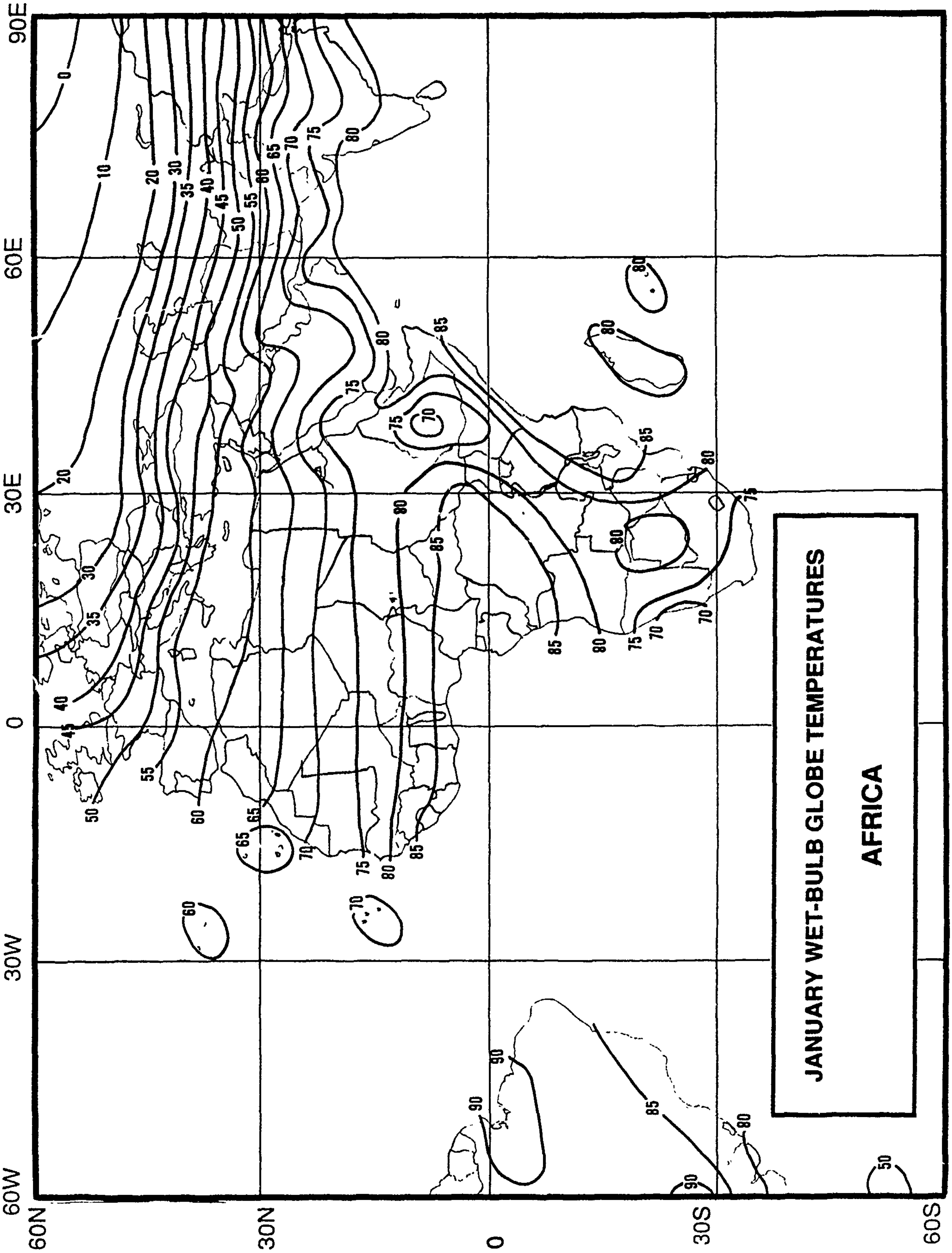
***July*** was selected to represent the hottest month in the northern hemisphere and the coldest month in the southern hemisphere.

***October*** represents the summer-winter and winter-summer transitions in the northern and southern hemispheres, respectively.



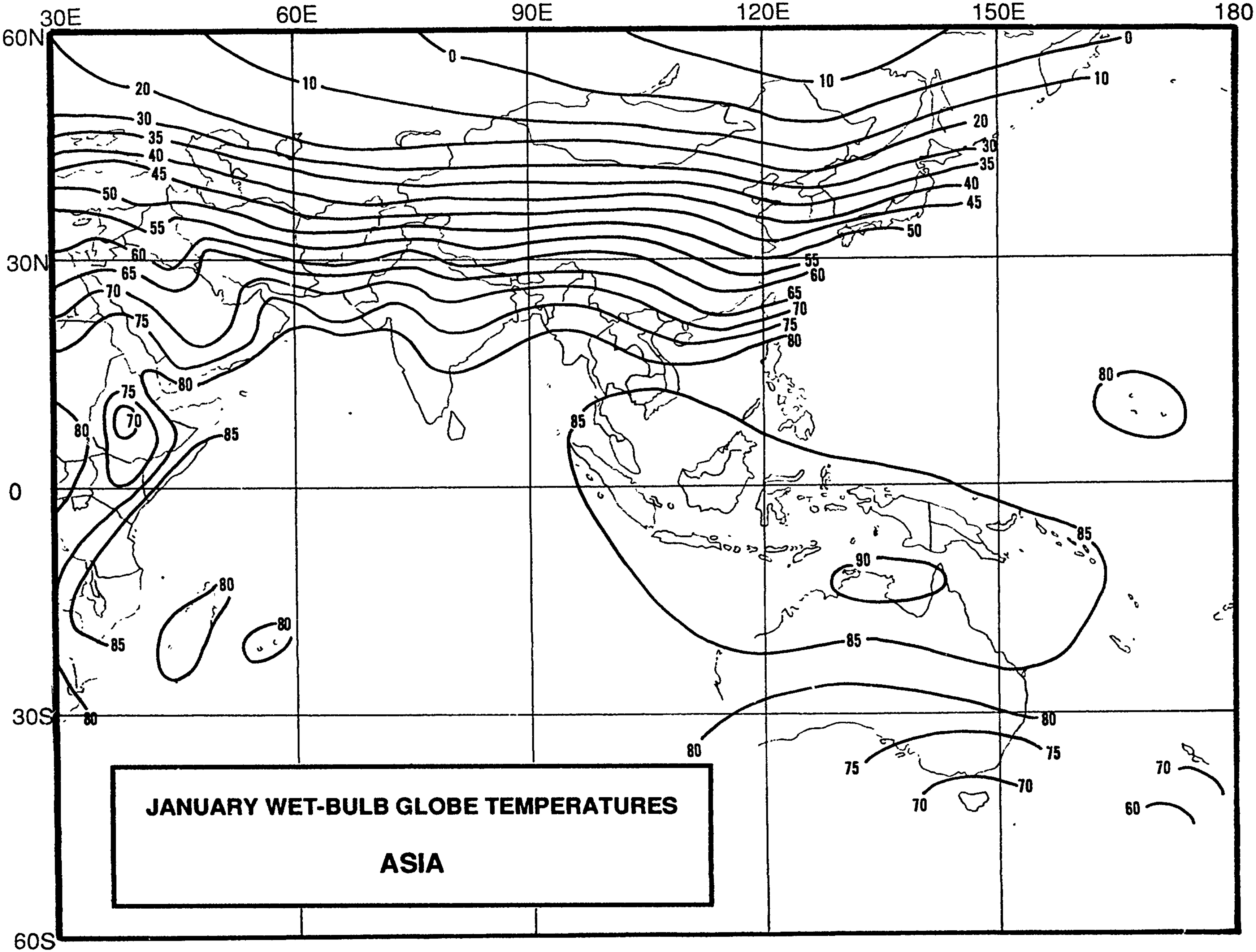

JANUARY WET-BULB GLOBE TEMPERATURES

NORTH & SOUTH AMERICA



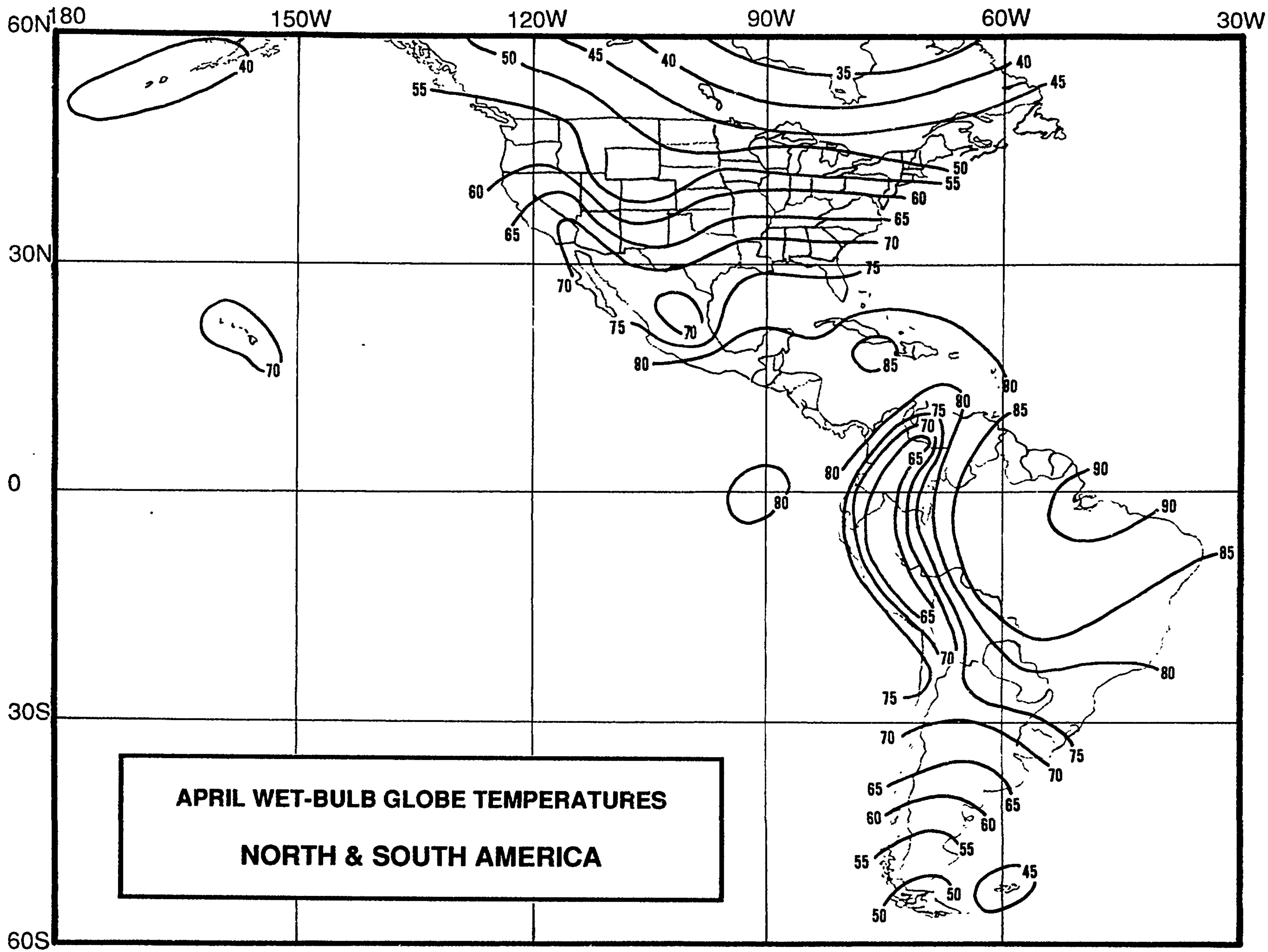

# JANUARY WET-BULB GLOBE TEMPERATURES

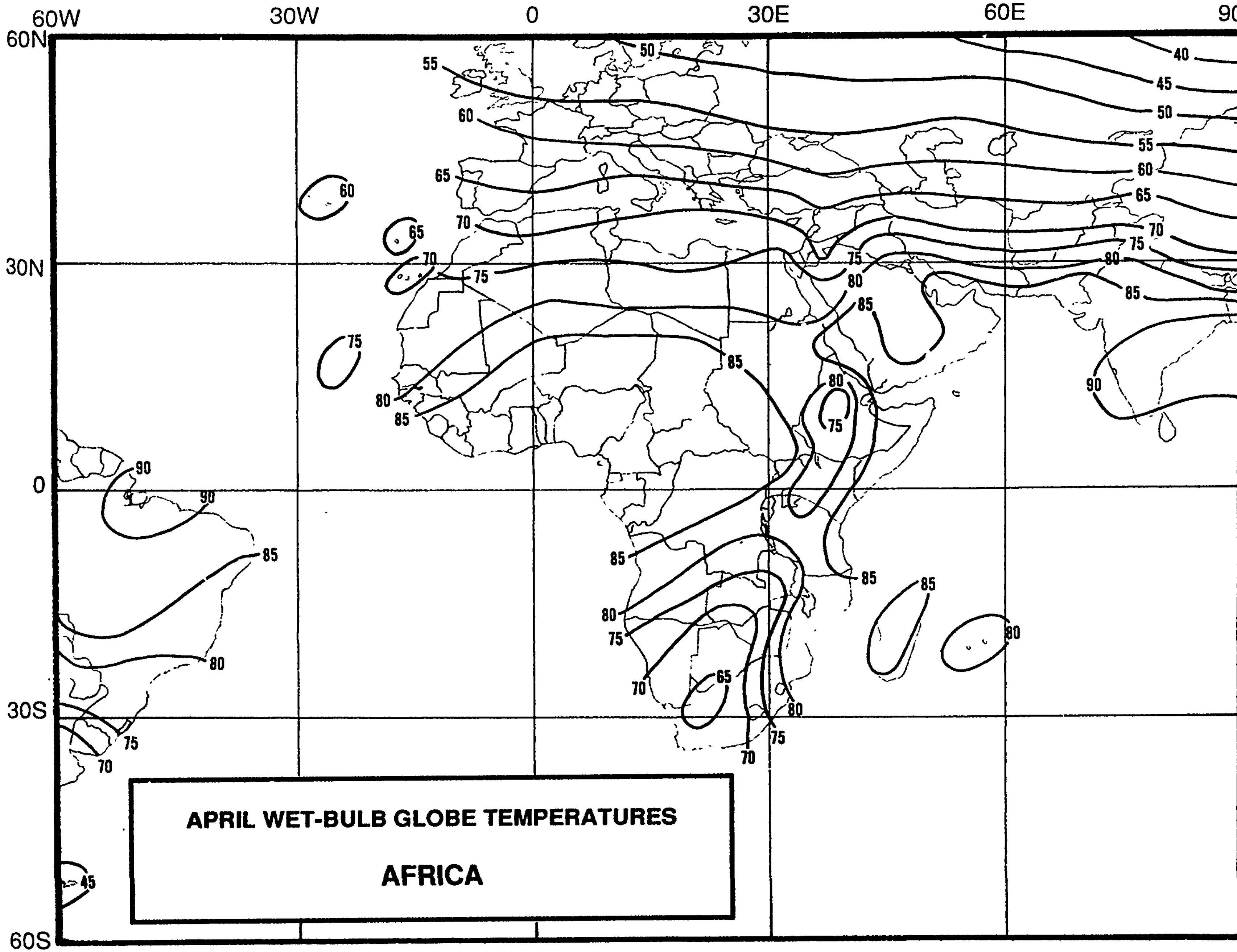
## AFRICA

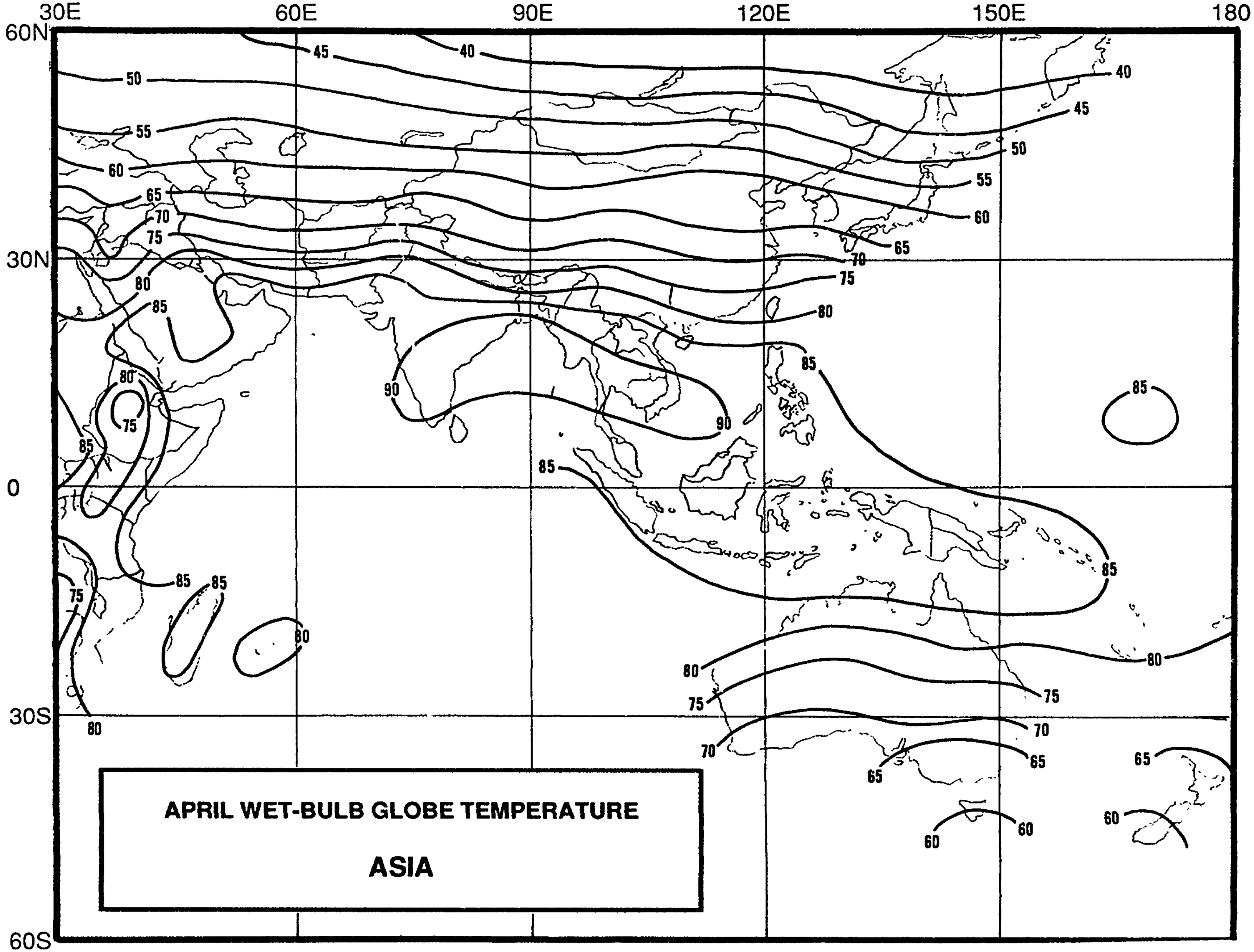



**JANUARY WET-BULB GLOBE TEMPERATURES**

**ASIA**

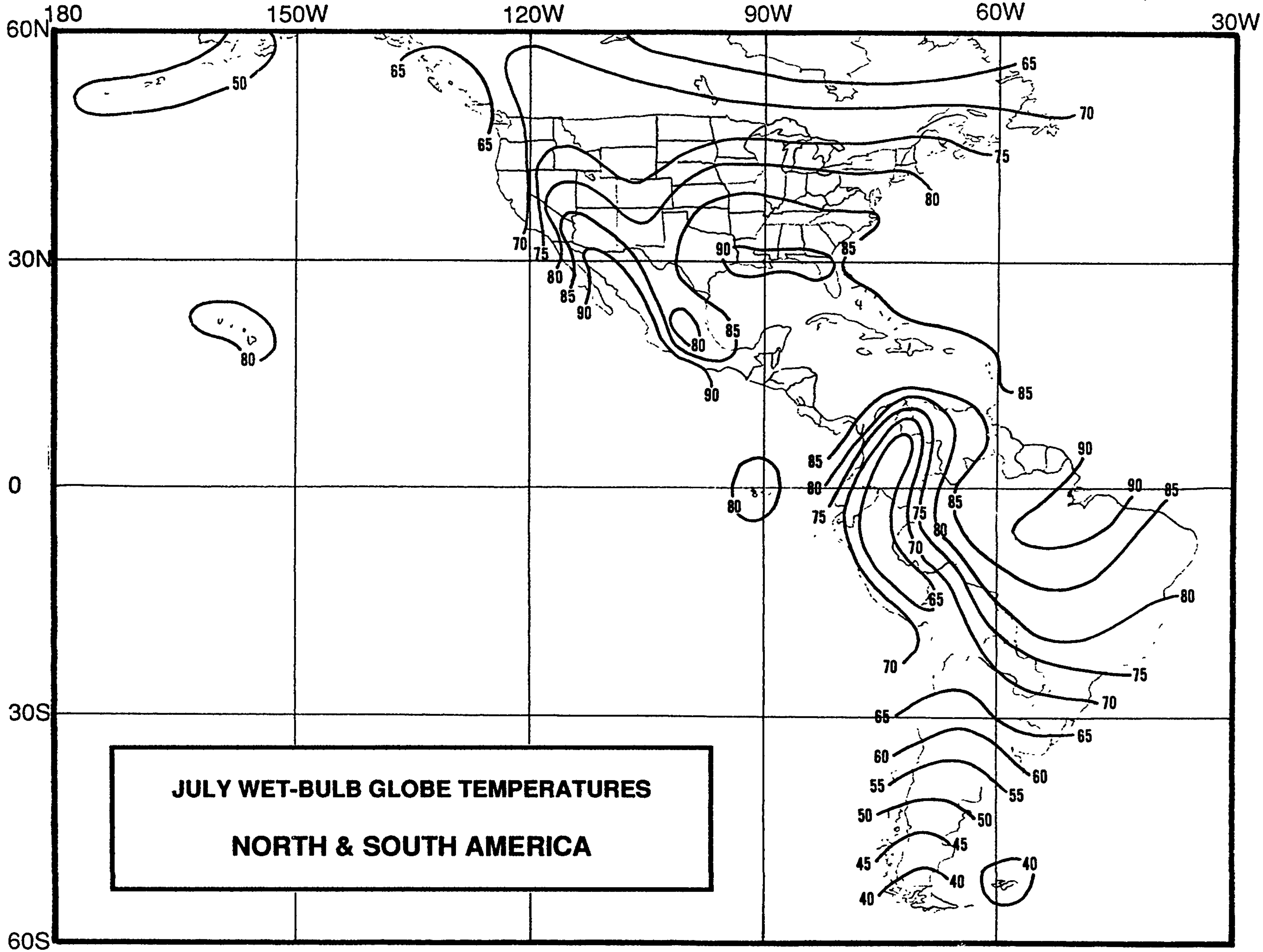

APRIL WET-BULB GLOBE TEMPERATURES
NORTH & SOUTH AMERICA
180
150W
120W
90W
60W
30W
60N
30N
0
30S
60S
35
40
45
50
55
60
65
70
75
80
85
90

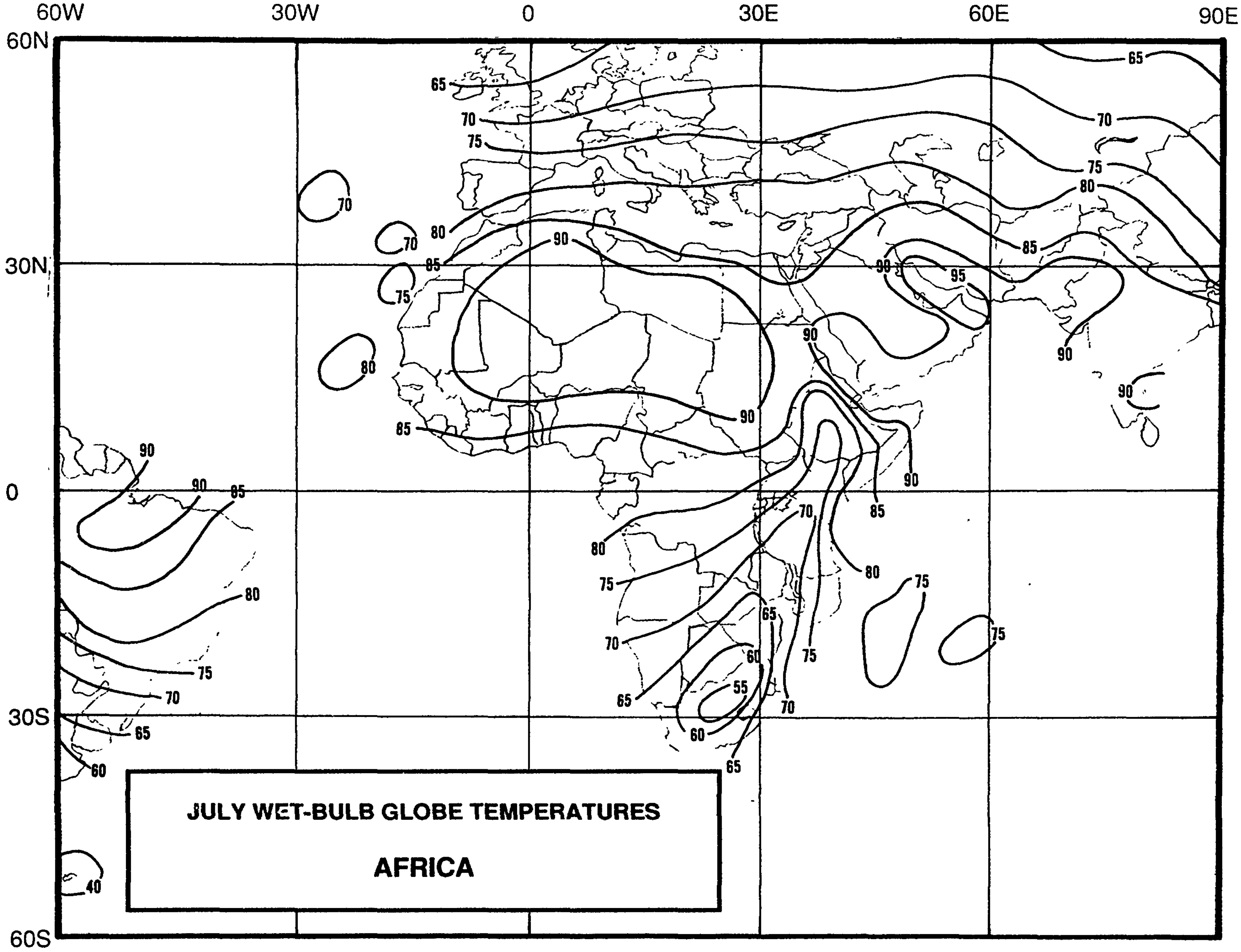

APRIL WET-BULB GLOBE TEMPERATURES
AFRICA
60W
30W
0
30E
60E
90E
60N
30N
0
30S
60S
40
45
50
55
60
65
70
75
80
85
90




APRIL WET-BULB GLOBE TEMPERATURE

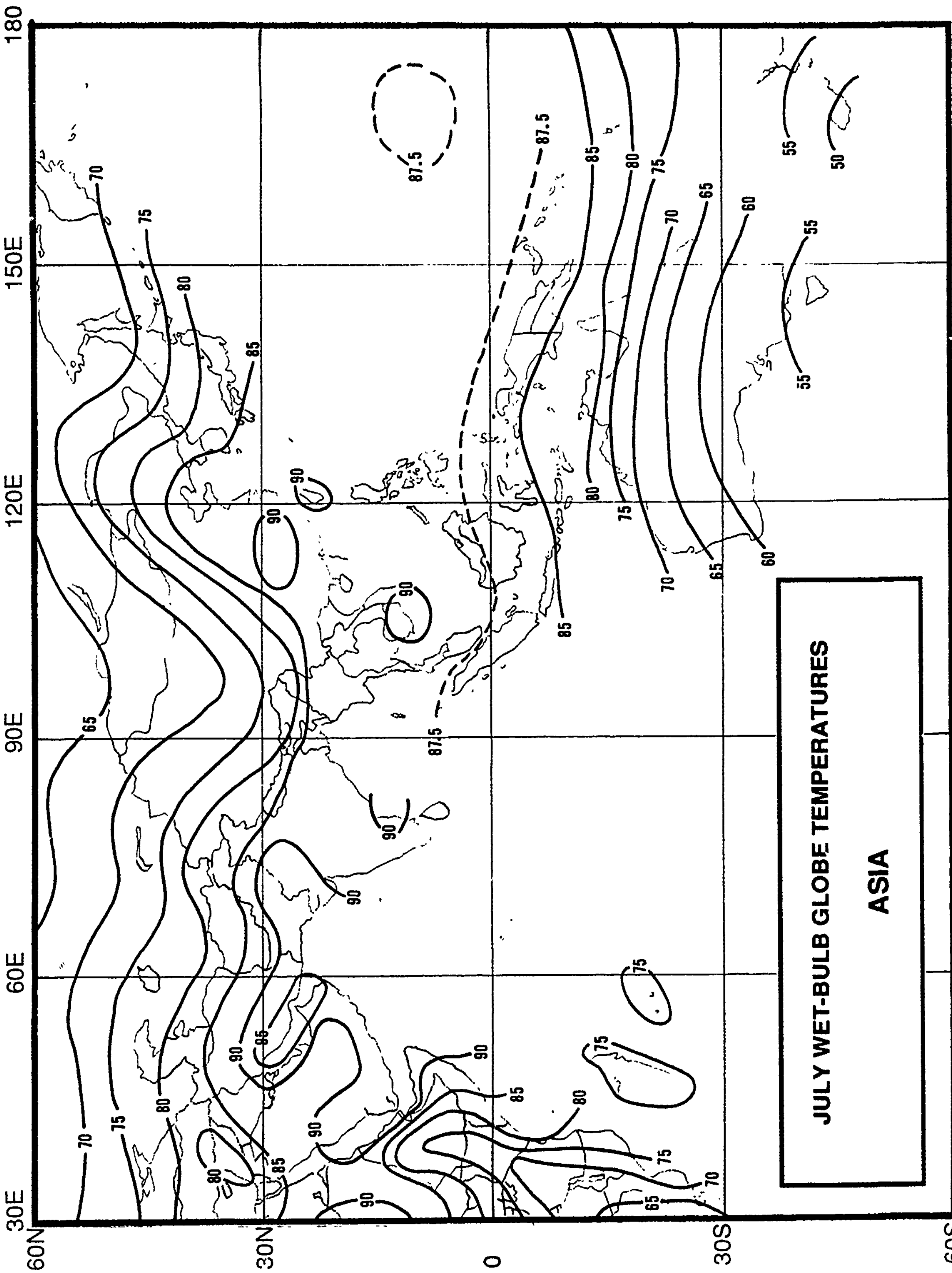
ASIA

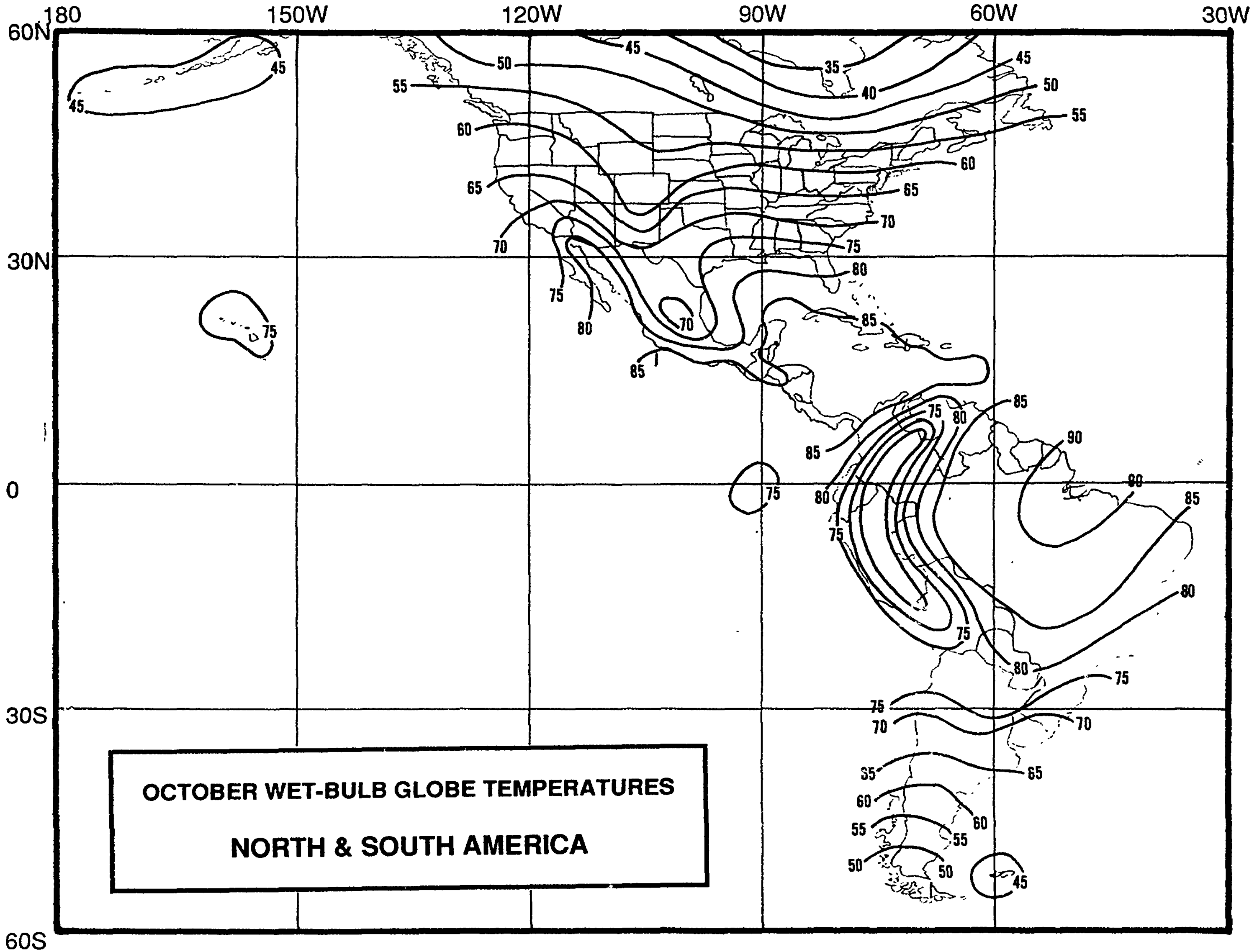

JULY WET-BULB GLOBE TEMPERATURES
NORTH & SOUTH AMERICA
180
150W
120W
90W
60W
30W
60N
30N
0
30S
60S




**JULY WET-BULB GLOBE TEMPERATURES**

**AFRICA**

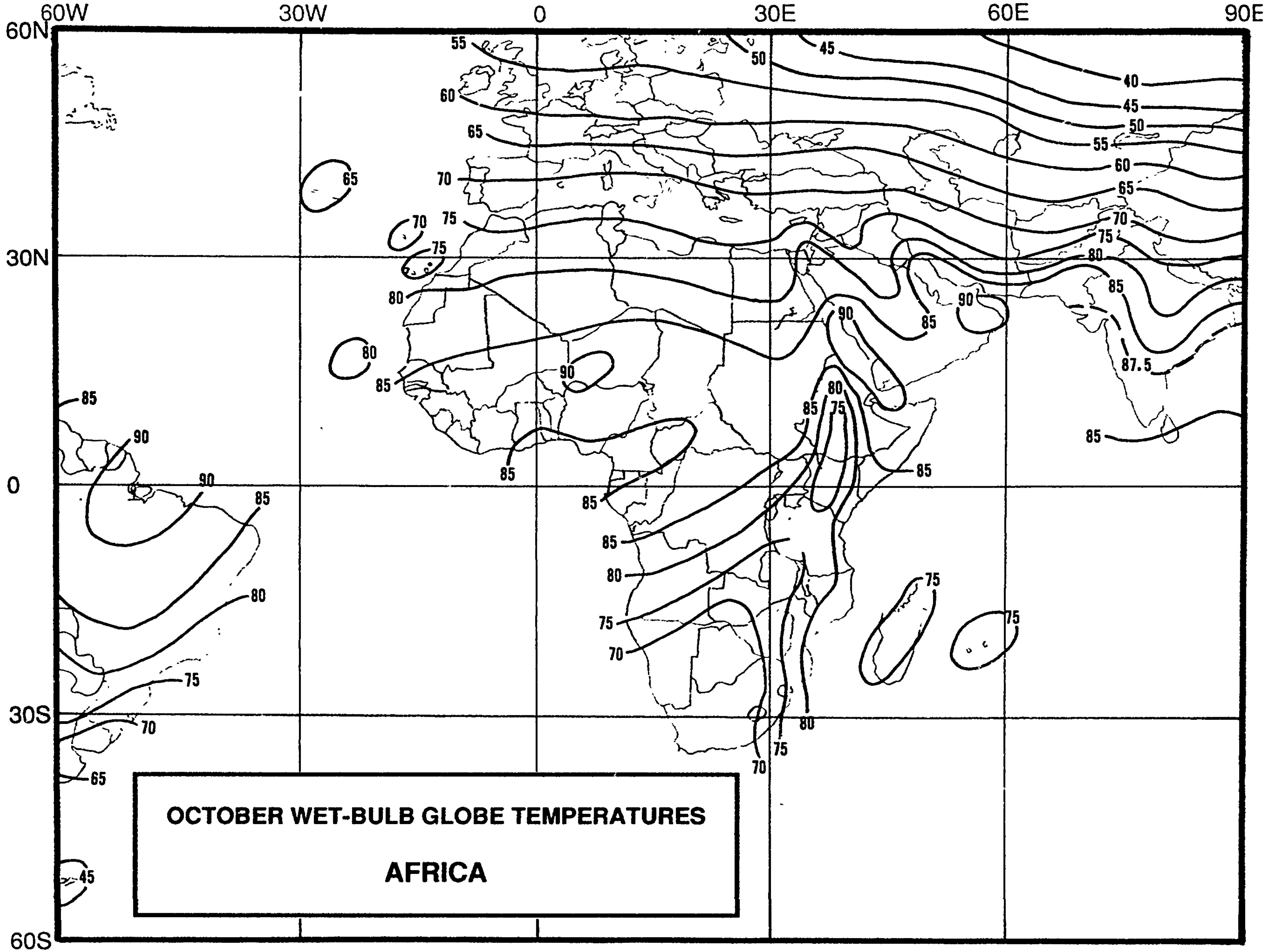

JULY WET-BULB GLOBE TEMPERATURES
ASIA
30E
60E
90E
120E
150E
180
60N
30N
0
30S
60S
65
70
75
80
85
87.5
90
95
60
55
50

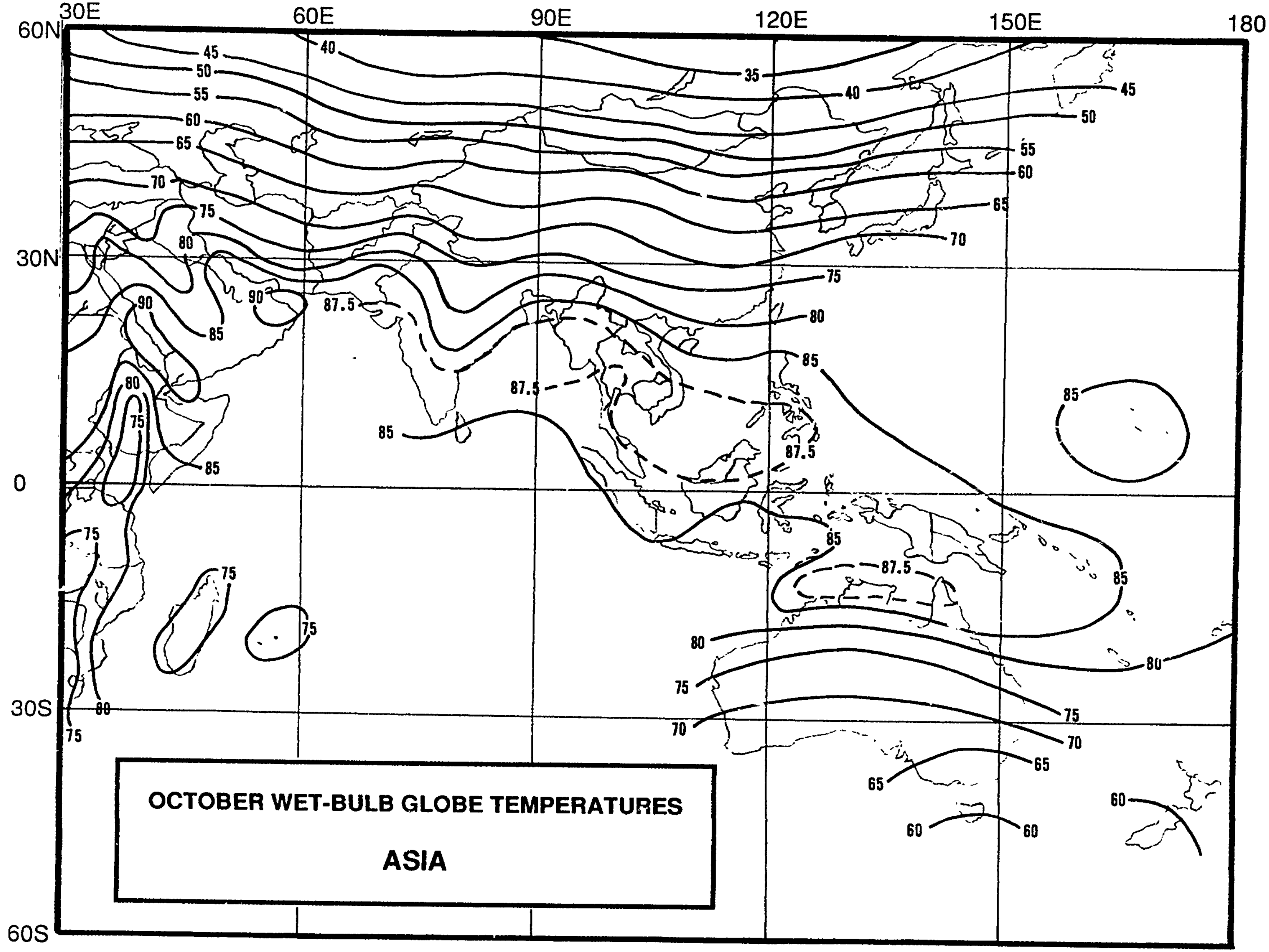


OCTOBER WET-BULB GLOBE TEMPERATURES
NORTH & SOUTH AMERICA
180
150W
120W
90W
60W
30W
60N
30N
0
30S
60S

## OCTOBER WET-BULB GLOBE TEMPERATURES

## AFRICA





OCTOBER WET-BULB GLOBE TEMPERATURES

ASIA

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*Weather Support for Army Tactical Operations*, FM 34-81/AFM 105-4, August 1989.

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