The White Light Solar Corona
An Atlas of K-Coronameter Synoptic Charts
December 1981 - January 1983

K. Rock
R. Fisher
C. Garcia
P. Seagraves
E. Yasukawa
Preface

The synoptic observing project of the High Altitude Observatory's Coronal Dynamics Program began on 5 August 1980. The data obtained by the Mark-III K-coronameter located at the Mauna Loa Solar Observatory, Hawaii, are published yearly in volumes of *The White Light Solar Corona; An Atlas Of K-Coronameter Synoptic Charts* (Table 1). The reader will notice a segment of overlapped data at both the beginning and the end of each volume. This is necessary to provide a complete data set of Carrington rotations covering a specific time period because west limb passage occurs 14 days after the east limb passage.

This set of synoptic data should be regarded as a preliminary presentation in which no corrections have been made for the day-to-day variations in sky transmission and scattering of polarized light by the earth's atmosphere. While there is some inaccuracy incurred in neglecting these effects, it is still possible to use the data set as a characterization of the white light corona. Data from the east and west limbs are presented separately, as transient and evolutionary changes in the white light corona substantially modify the distribution of coronal material over the 14 days between sequential limb transients.

We would like to acknowledge the continuing support of the NCAR Graphics group, who prepared the synoptic contour charts.

Kristine Rock
Mauna Loa Solar Observatory
Hilo, Hawaii
### TABLE I

Mark-III K-Coronameter Data

<table>
<thead>
<tr>
<th>ATLAS #1</th>
<th>August 1980 - September 1981</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATLAS #2</td>
<td>September 1981 - February 1982</td>
</tr>
<tr>
<td>ATLAS #3</td>
<td>December 1981 - January 1983</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

PREFACE

I. PROGRAM GOAL 1
II. DESCRIPTION OF DATA PRODUCTS 4
III. REFERENCES 6
IV. ACKNOWLEDGMENTS 7
V. SHADED SYNOPTIC CONTOUR CHARTS
I. PROGRAM GOAL

The synoptic observing program of the Mauna Loa Solar Observatory (MLSO) has as its goal the specification of the time-dependent structure of the solar corona. The rate of change of the corona, at least in a global sense, for a period of time around sunspot maximum was unknown at the outset of this study. The first year’s operation of the coronal dynamics (C/D) instrument system has yielded a data set that characterizes the coronal rate of change, for certain sized structures, at a time near the maximum of sunspot cycle 21. The second and third years of operation continues this effort in the declining phase of the sunspot cycle.

Although more data are available from the C/D archive in Boulder, Colorado, the material presented here is in a format providing a convenient access to an investigator intending to make correlation studies or an intercomparison of standard synoptic data sets. Specific requests may be made for a particular time period or for as-yet-unpublished data.

K-Coronameter Observations

The devise used to collect the data presented in the following pages is the imaging K-coronameter located at the Mauna Loa observing station of the High Altitude Observatory (HAO). The site is at +19° 31' latitude, 155° 38' west longitude on the island of Hawaii. The system was described in detail by Fisher et al. (1981). The synoptic observing program as begun on day 212 (DOY 212) of 1980. This publication continues work presented in the first two volumes of this series, Fisher et al. (1982a, b).

A subset of the data, azimuthal polarized brightness (pB) values at three selected heights in the corona, is selected from each day’s operation. This is done during the routine daily calibration procedure. Specific pB values
observed on the selected data set are estimated and recorded for the three heights. A discussion of the calibration system can be found in volume one of this atlas.

Calibration data are available in Hilo, Hawaii, so that secular variation in instrument sensitivity, atmospheric scattering of polarized light, and atmospheric transmission may be studied, if necessary. The reader is cautioned to remember that no attempt has been made to correct for these effects in the data presented in this atlas. There are times when errors in the estimate of the true pB signal may be as large as a factor of two. These days--days with cirrus clouds or volcanic emission within the field of view--are rather evident and generally produce a "band," a vertical defect, in the synoptic maps.

The instrument resolution remains unchanged from the description given in 1981. The sample aperture is 3.2 arc seconds wide at the limb of the sun and increases linearly to a width of 22.5 arc seconds at a height of 2.3 \( R_0 \). The height of the sample aperture is 10 arc seconds, regardless of height above the limb. This produces an image which is limited to 20 arc seconds at a height of 1.5 \( R_0 \). The resolution of the synoptic map is somewhat less than this in azimuth because of a process of "deglicking." This numerical procedure is necessary for the routine removal of high spatial frequency noise. The source of this noise is particulate matter (or insects) drifting through the diode field of view during the time of observation. The occurrence of such noise is relatively uncommon during the periods of data sampling in this study, but it does produce high spatial frequency artifacts in the final data which are annoying if not removed. Some azimuthal smoothing has been applied to the data set so that the effective resolution in latitude is \( \pm 1^\circ \). The longitude resolution yielded by the K-coronameter technique is quite a different matter. Since this study used one observation per 24-h period, the sampling theorem dictates that the minimum detectable separation of structures is two days' solar rotation as
viewed from the earth, or about 26° of longitude.

MLSO operates seven days per week year round, weather permitting. Observations were stopped briefly, then resumed on 4 January 1982 (DOY 4). After the installation of a new 11/44 Digital Equipment Corporation computer the computer interpolated the available data across the gap which is not apparent in the shaded synoptic charts, but appears marked in the DOY spaces at the bottom of each chart.

Synoptic data are kept on a computer disk at the Mauna Loa site. Synoptic contour maps are prepared by the operations crew at the sea-level base in Hilo. The entire observing and data reduction effort is kept intact at the Hawaiian facility. Further requests concerning the material presented here, or questions concerning the method of preparation (or display) may be addressed to either:

R. Fisher  
High Altitude Observatory  
P.O. Box 3000  
Boulder, CO 80307

Kristine Rock  
High Altitude Observatory  
P.O. Box 425  
Federal Building  
Hilo, HI 96720

For those readers requiring the *ATLAS* data in digital format, it is now possible to write *ATLAS* data onto 1800 bpi magnetic tape. Data users requesting digital data should supply the observatory with a blank tape and details of the time of coverage desired. Information in the *ATLAS* tape format may be obtained from:

P. Seagraves  
High Altitude Observatory  
P.O. Box 425  
Federal Building  
Hilo, HI 96720
II. DESCRIPTION OF DATA PRODUCTS

Synoptic Contour Charts

The data are plotted in a rectangular format. Two heights, 1.3 and 1.7 \( R_\odot \), are used, and the data from the east and west limbs are plotted separately. On days when it was impossible to observe, a notation of "X" is printed in the DOY space. Data for each Carrington rotation period are shown as surface contours with units of \( \text{pB} \times 10^{-8} \text{ erg cm}^{-2} \text{ sr}^{-1} \times \text{percent polarization} \). The latitude lines of 90°N, 0°, and 90°S are marked on each chart. Solar longitude is not used as the unit of measure along the abscissa; rather the data are plotted as a function of time. The Carrington rotation number is given under the title of the plot; the limb over which the observations were made and the height are given at the left-hand corner. Data from the highest scan, the "outer" scan, are not included in this work, since the average signal-to-noise ratio is, at best, about 1:1.

The synoptic contour plots have been converted into a format in which \( \text{pB} \) resolution is quantified into five levels. This has been done to clarify the morphology of the corona for the identification of white-light structures with other solar features. The levels are specified in Table II.
TABLE II
Synoptic Chart Level in \( pB \times 10^{-8} \)

<table>
<thead>
<tr>
<th>Height</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3( R_0 )</td>
<td>1.7( R_0 )</td>
</tr>
<tr>
<td>BLACK pB &lt; 0</td>
<td>pB &lt; -1</td>
</tr>
<tr>
<td>WHITE 0 &lt; pB ≤ 4</td>
<td>-1 &lt; pB ≤ 0</td>
</tr>
<tr>
<td>DOT 4 &lt; pB &lt; 8</td>
<td>0 &lt; pB ≤ 1</td>
</tr>
<tr>
<td>DASHED 8 &lt; pB ≤ 12</td>
<td>1 &lt; pB ≤ 2</td>
</tr>
<tr>
<td>LINED &gt; 12</td>
<td>&gt; 2</td>
</tr>
</tbody>
</table>

Regions of lower density (black) frequently have negative values for the inferred polarized brightness. This is the result of scattering of photospheric light by the earth's atmospheric gases as well as scattering by small particles suspended in the line of sight. There is some variation in this effect from day to day as well as variation introduced by other natural phenomena. Ordinarily the effect of scattered light is quite small, less than \( \pm 0.3 \) pB peak to peak; but during 1982 scattering by volcanic debris increased this effect considerably. The average effect is to place a bias of -0.75 pB on the 1.7 \( R_0 \) surface between DOY 125 and DOY 324 (Garcia and Yasukawa, 1982). The slow clearing of the stratosphere has reduced this bias gradually from DOY 324 onwards.
III. REFERENCES

Fisher, R., R. Lee, R. MacQueen, and A. Poland, 1981: New Mauna Loa corona-

Light Solar Corona; An Atlas of K-Coronameter Synoptic Charts: August
Colo., 119 pp.

Light Solar Corona; An Atlas of K-Coronameter Synoptic Charts, September
Colo., 26 pp.

Garcia, C., and E. Yasukawa, 1982: Mauna Loa sky conditions: Benchmark and
present. *EOS, Trans. AGU 63 (45)*, 897.
IV. ACKNOWLEDGMENTS

The authors acknowledge the assistance of C. Baker, B. Alves, and K. Lynch in the preparation of this manuscript. The shaded synoptic charts were prepared by the NCAR Graphics group.
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1717  HEIGHT 1.3 R⊙

EAST LIMB  NORTH
+90
0
-90

WEST LIMB  NORTH
+90
0
-90

PB 12 8 4 0
X=NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1717 HEIGHT 1.7 \( R_\odot \)

EAST LIMB

NORTH

SOUTH

WEST LIMB

NORTH

SOUTH

X = NO DATA

PB 2 1 0 -1
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1718  HEIGHT 1.3 R⊙

EAST LIMB
NORTH

WEST LIMB
NORTH

PB 12 8 4 0
X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1719 HEIGHT 1.3 R_
EAST LIMB
WEST LIMB
X= NO DATA
PB 12 8 4 0
NORTH
SOUTH
X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1719 HEIGHT 1.7 R₆

EAST LIMB
NORTH

+90

-90

SOUTH

WEST LIMB
NORTH

+90

-90

SOUTH

X = NO DATA

PB 2 1 0 -1
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1720 HEIGHT 1.3 R☉
HIGH ALTITUDE OBSERVATORY MAUNA LOA

MK III K-CORONAMETER

ROTATION 1720  HEIGHT 1.7 R₀

X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1721  HEIGHT 1.3 Rₚ

EAST LIMB
WEST LIMB

NORTH
SOUTH

+90
0
-90

DOY

SOUTH

WEST LIMB

SOUTH

X = NO DATA

PB 12 8 4 0
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1722  HEIGHT 1.3 R⊙

EAST LIMB
WEST LIMB

X = NO DATA

PB 12 8 4 0

X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1722  HEIGHT 1.7 R_

EAST LIMB  NORTH

WEST LIMB  NORTH

X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1723    HEIGHT 1.3 R_e

EAST LIMB

WEST LIMB

NORTH

SOUTH

X=NO DATA

PB 12 8 4 0
HIGH ALTITUDE OBSERVATORY MAUNA LOA

MK III K-CORONAMETER

ROTATION 1726  HEIGHT 1.3 R⊙

EAST LIMB

NORTH

WEST LIMB

NORTH

SOUTH

PB 12 8 4 0

X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1728 HEIGHT 1.3 R☉
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1728 HEIGHT 1.7 R☉
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1729 HEIGHT 1.3 R_

EAST LIMB
PB 12 8 4

WEST LIMB
PB 12 8 4

X = NO DATA

PB 12 8 4 0
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1729   HEIGHT 1.7 $R_\odot$

EAST LIMB

NORTH

WEST LIMB

NORTH

SOUTH

SOUTH

X = NO DATA
HIGH ALTITUDE OBSERVATORY MAUNA LOA
MK III K-CORONAMETER
ROTATION 1730 HEIGHT 1.7 \( R_\odot \)

EAST LIMB NORTH

WEST LIMB NORTH

SOUTH

X = NO DATA

PB 2 1 0 -1