Abstract. A large number of synoptic maps from a variety of instruments are used to show the general morphology of the Sun at the time of the First Whole Sun Month Campaign. The campaign was conducted from August 10 to September 8, 1996. The synoptic maps cover the period from Carrington rotation 1912/253° to Carrington rotation 1913/45°. The synoptic maps encompass both on-disk data and limb data from several heights in the solar atmosphere. The maps are used to illustrate which wavelengths and data sets show particular features, such as active regions and coronal holes. Of particular interest is the equatorial coronal hole known as the "elephant's trunk," which is clearly evident in the synoptic maps of on-disk data. The equatorial coronal hole of 1973/1977. What is less striking, but no less important, is the azimuthal symmetry and narrowness of the coronal streamer belt 180° in longitude away from the elephant's trunk. This quiet side of the Sun is useful, in fact ideal, for modeling the density and other physical parameters of the Sun. The Sun thus presents two very different pictures and we put together here what we believe to be the widest variety of synoptic maps ever published in one paper, and we point out the visible features and explain some of the similarities and differences in the maps.

1. Introduction

This paper, the first in this special section of papers from the Whole Sun Month Campaign, provides an overview of the campaign and puts the state of the Sun at this time clearly in perspective. Synoptic maps are used to show how the Sun appeared during the campaign. The features and appearance of the synoptic maps are explained.

Synoptic maps are used extensively to show how the state of the Sun varies with time; thus providing an historical record of the Sun (e.g., see Solar Geophysical Data). Synoptic maps are useful because they show a lot of information in a very concise and clear way and reading them is straightforward. However, most published papers which include synoptic maps usually include maps from only a few sources. Given a synoptic map, one can often identify certain features, such as active regions and coronal holes, rather easily. Whether a feature such as a prominence or a polar plume appears on a synoptic map depends on the wavelength and height of the observations. We put together here what we believe to be the widest variety of synoptic maps ever published in one paper, and we point out the visible features and explain some of the similarities and differences in the maps.

A large variety of synoptic maps have been compiled at a range of heights and wavelengths. All of these maps are from the time of the Whole Sun Month (WSM) Campaign, which was conducted from August 10 to September 8, 1996. These maps show a variety of solar features as a function of wavelength, height in the atmosphere, and also viewing angle.

The most striking feature of these synoptic maps which appears at almost all wavelengths and heights is the equatorial coronal hole which extends from the north polar coronal hole all the way down into the southern hemisphere. It then reaches out to the large active region (NOAA AR7986) which is also clearly visible in most of the on-disk maps. This equatorial coronal hole has been dubbed the elephant's trunk. The overall shape of the elephant's trunk coronal hole is similar to the famous Skylab "Boot of Italy" or "CH1" equatorial coronal hole of 1973 [Bohlin, 1977]. What is less striking, but no less important, is the azimuthal symmetry and narrowness of the coronal streamer belt 180° in longitude away from the elephant's trunk. This quiet side of the Sun is useful, in fact ideal, for modeling the density and other physical parameters of the Sun. The Sun thus presents two very different pictures and we can divide the Sun into two halves; one which is active and complex and one which is quiet and simple.

2. Campaign

The Whole Sun Month Campaign was organized to try to describe, with both data and models, the state of the large-scale structure of the Sun at solar minimum. The primary interest is in the stable Sun, so transient solar activity during the Whole Sun Month has not been examined in great detail. Transient activity was relatively low during the campaign, with coronal mass ejections observed by SOHO/LASCO at a rate of about 1 every 2 days (St. Cyr, personal communication, 1998). In the campaign, near-simultaneous measurements were brought together from a wide variety of instruments, both ground and space based. Because of the concentration on stable structures, absolutely simultaneous observations were not required. The data were made freely available so various
modelers and data analysts could compare results using the same data set.

Some of the instruments which took part in the campaign did so by making special observations. Others used only daily synoptic data. Some observatories and instruments only supplied data after the campaign had been run. In the interest of space, not all data from all possible instruments or all possible data sets are included in this paper. In particular, the in situ heliospheric data have not been used. Those which are included in this paper are: SOHO/MDI, SOHO/EIT, SOHO/CDS, SOHO/UVCS, SOHO/LASCO, Yohkoh/SXT, Mauna Loa/Mk3, and Nobeyama Radioheliograph.

2.1. Motivation

The campaign was motivated by several factors. First, there was an impressive array of instruments monitoring the Sun at one time. The launch of the SOHO spacecraft in December 1995 added 12 instruments to the array of ground- and space-based instruments already operating. Second, it was felt that the quality of the data would enable better determination of solar properties such as density, temperature, magnetic field, and velocity. Finally, these improved data sets would enable theoretical models to be improved.

By using a large number of instruments, we wanted to not only have complementary data, but also to test the data. For example, the electron densities measured for a specific location and height in the corona should be the same, no matter which instrument is used to determine the density. Comparisons of the data for various parameters have been done for the WSM Campaign and appear in several papers [e.g., Alexander, this issue; Fludra et al., this issue; Gibson et al., this issue; Guhathakurta et al., this issue].

The large-scale structure of the heliosphere is one example of a problem that requires an extensive campaign such as WSM. One can observe the solar disk and lower corona with remote sensing instruments. In situ measurements can be made wherever there are spacecraft. However, the regions of the heliosphere between the lower corona and separate spacecraft (typically at 1 AU and beyond), as well as the space between the spacecraft are completely unsampled. Modeling must be brought to bear on this problem. Several authors have combined a variety of observations and modeling to show not only how the solar features seen in synoptic maps are connected to in situ measurements but also which coronal features and diagnostics are important in helping to determine the large-scale structure of the heliosphere [Breen et al., this issue; Posner et al., this issue; Riley et al., this issue; Linker et al., this issue; Forsyth et al., 1998].

3. Synoptic Maps

The primary campaign observations were conducted from August 10 to September 8, 1996. Synoptic maps are shown for both on disk measurements at central meridian (CM) and for limb measurements. The synoptic maps cover Carrington rotations (CROT) 1912/253° to 1913/45°, corresponding to the period from August 3 to September 15 for central meridian. However, maps which are taken from data at the limbs are shifted in time by ¼ rotation forward and backward from central meridian. Thus, the dates of the east limb data run from July 27 to September 8 and the west limb data run from August 9 to September 21. Note that the maps cover more than one solar rotation (~1.6 rotations). Therefore certain features, those between 45° and 253° in each rotation, are visible for 2 rotations. Thus there is the opportunity to consider the evolution of certain features.

This paper is concerned only in comparisons of the morphology of the data, so the intensity scales on the maps are arbitrary.

3.1. Central Meridian Data

The synoptic maps of CM data (Plates 1 and 2) are created by extracting a strip of data of finite width in longitude centered on the central meridian. Missing data have been filled in where possible by increasing the width of the neighboring strip. The data are then plotted as a function of latitude and Carrington longitude. The south pole is not visible in the CM maps because of the tilt of the solar equator (B₀ ~ 7°).

3.1.1. MDI. The MDI [Scherrer et al., 1995] synoptic chart shows the strength of the photospheric magnetic field during Whole Sun Month (Plate 1a). The map has been assembled from near central meridian observations from full-disk magnetograms with a resolution of 2° taken every 96 min.

Even though the WSM campaign took place near solar minimum, the magnetic structures still present some interesting and complex characteristics. The data show that the old solar cycle, number 22, still determines the orientation of features at low latitudes, while cycle 23 is showing itself at high latitudes. The leading polarity for cycle 23 is positive (white in Plate 1a) in the northern hemisphere; one obvious example is near 70° longitude at about 30° N. The highest northern latitude old cycle region is visible at about 20° and the lowest latitude at which the new cycle is visible is about 30°. In the southern hemisphere, there is a fairly young, old-cycle active region at 260° longitude near 10° S that has emerged in a larger decaying plage structure. The most equatorward new cycle regions are at about 25° south latitude. In these regions the negative polarity is leading, as expected for cycle 23, though the polarities are oriented nearly N-S, possibly as a result of the mixing of the two cycles in these regions.

The magnetic fields outside of the polar regions evolve significantly during the WSM Campaign. All of the strong northern hemisphere high latitude bipolar features decay from CROT 1912 to CROT 1913. Smaller features have even shorter lifetimes. In the southern hemisphere, small new-cycle midlatitude regions appear at longitudes 140° and 300° and the large old-cycle region near 260° becomes much less complex.

Note that all of the strong bipolar field regions on the Sun are correlated with intense features in all of the on-disk synoptic maps of EIT, CDS, YOHKOH/SXT, and the Nobeyama Radioheliograph. These maps encompass a wide range of heights and emission processes in the solar atmosphere. This confirms that the bipolar fields are associated with the dominant emission processes at all observed heights.

3.1.2. EIT and CDS. The EIT [Delaboudiniere et al., 1995] meridional maps were compiled from 2.6° resolution, full-disk images with a 6-hour cadence. The maps extend out to
Table 1. EIT and CDS Filter Bandpasses

<table>
<thead>
<tr>
<th>Detector</th>
<th>Label</th>
<th>Ion</th>
<th>Wavelength, Å</th>
<th>Temperature, MK</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIT</td>
<td>304</td>
<td>He II</td>
<td>303.7</td>
<td>0.05</td>
<td>dominant on disk</td>
</tr>
<tr>
<td>EIT</td>
<td>171</td>
<td>Si XI</td>
<td>303.3</td>
<td>1.6</td>
<td>significant in active regions and dominant above limb</td>
</tr>
<tr>
<td>EIT</td>
<td>195</td>
<td>Fe IX</td>
<td>171.0</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>EIT</td>
<td>195</td>
<td>Fe X</td>
<td>174.5</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>EIT</td>
<td>177.2</td>
<td>Fe XI</td>
<td>177.2</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>CDS</td>
<td>284</td>
<td>Fe XV</td>
<td>284.1</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>CDS</td>
<td>584</td>
<td>He I</td>
<td>584.33</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>CDS</td>
<td>630</td>
<td>O V</td>
<td>629.73</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>CDS</td>
<td>368</td>
<td>Mg IX</td>
<td>368.07</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>CDS</td>
<td>367.68</td>
<td>Mg VII</td>
<td>367.68</td>
<td>0.63</td>
<td>&lt;10%</td>
</tr>
</tbody>
</table>

EIT synoptic maps which are characteristic of a range of different heights/temperatures are shown: chromosphere (He II; 304 Å) (Plate Ib), transition region/corona boundary (Fe IX–Fe X; 171 Å) (Plate 1c), and the quiet chromosphere (He II; 304 Å) (Plate Ib), transition region/active region (He I; 584 Å) (Plate 2a), transition region (O V; 630 Å) (Plate 2b), corona (Mg IX; 368 Å), and active regions (Fe XVI; 360 Å). The CDS Mg IX and Fe XVI maps are not shown.

The CDS meridional maps were compiled from 2° × 1.68° resolution data. The maps consist of a series of central meridian strips, compiled from daily central meridian scans 4° wide. Missing data appear as black rectangles.

CDS records the EUV spectrum in the range 151–780 Å [Harrison et al., 1995]. A synoptic observation along the central meridian was carried out daily, using four bright lines, characteristic of different temperature regimes: chromosphere (He I; 584 Å) (Plate 2a), transition region (O V; 630 Å) (Plate 2b), corona (Mg IX; 368 Å), and active regions (Fe XVI; 360 Å). The CDS Mg IX and Fe XVI maps are not shown.

Table 1 lists the spectral lines contributing to the EIT and CDS bandpasses, along with the temperature at which the features shown in the EIT 171 Å, CDS 368 Å, and EIT 195 Å maps represent hotter temperatures (see Table 1), and the structures evident in these maps correspond better to large-scale coronal structure than the cooler lines. The northern polar coronal hole boundary is visible at all longitudes, in contrast with the southern polar coronal hole. This is partially due to the observing angle, which was (Bp = -7°) north of the ecliptic plane throughout the period of observation. The southern polar coronal hole boundary is closest to the pole at Carrington longitude 260°, presumably because of its proximity to the active region. The strong magnetic fields of the region may have allowed open field lines to close, and additionally, the strong coronal emission may obscure parts of the southern coronal hole. This is even more evident in the Yohkoh SXT map (Plate 2c and section 3.1.3), where the large-scale coronal structure allows the emission from higher altitudes to dominate the on-disk brightness, and even extends far beyond the southern limb.

The elephant's trunk coronal hole is most visible in the hotter wavelengths, while it is not as visible in the EIT 171 Å and CDS 368 Å maps. Slightly to the left of the elephant's trunk coronal hole these maps show a dark lane extending along a neutral line which is identified as a filament channel (see Nobeyama section 3.1.4). In contrast, the "quiet" half of the rotation resembles more of a typical solar minimum Sun. Still, the polar coronal hole boundaries are structured, showing evidence for equatorward extensions of the coronal holes. The polar coronal hole boundaries evolve slowly, showing similar structure over both rotations visible in the maps. Corresponding solar wind observations indicate this as well [Posner et al., this issue]. Thus the assumption that the coronal structure is static is reasonably valid.

3.1.3. SXT. The synoptic map of the soft X ray corona during the WSM campaign (Plate 2c) was generated from full-disk images taken by the Soft X ray Telescope (SXT) on board the Yohkoh spacecraft [Tsuneta et al., 1991]. Each processed image used to make the map was a composite; comprising a combination of long (5.6 s) and short (0.168 s) exposures.
to yield the large dynamic range seen in Plate 2c. All images were taken using the Al/Mg/Mn ("dagwood sandwich") filter on the SXT which covers a wavelength range of approximately 3-30 Å with each image having a spatial resolution of 4.9".

The SXT synoptic map shows a number of interesting features. The main thing to note is that at soft X ray energies, the Sun during the WSM campaign was extremely quiet with only one major active region (NOAA AR7986) traversing the disk during this time. As at the other wavelengths shown in this paper, the X ray Sun has asymmetrically active hemispheres, a feature that is evident for several rotations prior to and following the Whole Sun Month. The thermal response of the SXT filters results in a bias toward higher temperatures and as a result active regions and X ray bright points stand out clearly in the synoptic map. These features are cospatial with MDI bipolar field regions (see Plate 1a).

A comparison with the EIT synoptic maps show a close similarity between the 284 Å (not shown) line of EIT and the SXT data indicating that the median temperature of the hot corona during this time is of the order of 2 × 10^6 K (AR7986 displays temperatures in excess of 5 × 10^6 K). In addition to the bright features seen in the SXT synoptic map, the boundaries of the north polar coronal hole together with its numerous southward extensions are well delineated. These extensions may be the source region of the fast solar wind as detected by in-situ instruments [Posner et al., this issue].

3.1.4. Nobeyama. The Nobeyama Radioheliograph synoptic map (Plate 2d) is made from full disk microwave images at 17 GHz. The Nobeyama Radioheliograph is a dedicated instrument observing the Sun for ~8 hour per day with a temporal resolution of 100 ms. The synoptic map is constructed from the best daily image obtained around local noon (0300 UT), so the resolution in longitude is about 13°. The spatial resolution of the daily images is about 10°. The contours are drawn at a brightness temperature of 10500 K and are used to highlight the prominent features of the map.

Inspection of the Nobeyama map shows that coronal holes at both poles are dark green, corresponding to a higher intensity, as compared to the lighter green of the quiet closed field coronal regions. This is known as polar cap brightening, previously described by Kosugi et al. [1986]. The brightening in the coronal holes probably results from the temperature structure of the upper chromosphere or transition region in the coronal hole which may be different from that in the quiet solar atmosphere [Withbroe, 1977; Kosugi et al., 1986; Gopalswamy et al., 1998]. Microwave limb brightening may also contribute to the radio enhancement at the poles.

The elephant's trunk coronal hole is not easy to distinguish in the microwave data. As in the case of the polar coronal holes, the microwave emission is enhanced in the low-latitude coronal hole. However, the enhancement is not uniform but occurs in small patches along the elephant’s trunk. Comparison with the MDI photospheric magnetic field map (Plate 1a) shows that these patches of enhanced radio emission correspond to regions of enhanced unipolar magnetic flux. This may have important implications for the origin of solar wind in coronal holes. It is known that the height at which the 17-GHz radio emission is generated is low in the atmosphere. The inability to clearly distinguish the elephant’s trunk coronal hole is also found in the low-latitude EIT maps at 304 Å (Plate 1b). The correspondence between microwave and EUV fine structures within the coronal hole may help us understand the physical processes taking place in the coronal hole.

Comparison to the MDI map also shows that the bipolar field features are all bright in microwaves as well. The microwave emission from the bipoles is due to thermal free-free emission from the plasma trapped in the bipolar magnetic field. There is a filament visible as a dark feature at high southern latitudes between longitudes 0° and 25°. The filament is dark because it is at a lower temperature (~8000 K) compared to the microwave quiet Sun (~10,000 K). For the same reason, filament channels appear as prominent dark features, as in the one to the left of the elephant’s trunk coronal hole.

3.2. Limb Data

The limb data synoptic maps (Plates 3 and 4) are created by extracting an annulus of data at the specified heliocentric distance from the Sun. The data are then "straightened" and plotted with the vertical axis representing latitude (position angle). All data are from the east limb except for Plate 4d. Missing data are filled in by interpolating across existing data, unless otherwise noted.

3.2.1. EIT and LASCO C1. The EIT 195 Å off-limb map (Plate 3a) was constructed from the EIT 2.6° resolution synoptic data. The 6-hour cadence results in a 3° resolution in longitude in the limb maps. Long durations without available data are evident as black regions on the maps.

The LASCO [Brueckner et al., 1995] C1 map (Plate 3b) shows the intensity of the green line Fe XIV emission with the continuum emission subtracted. The map was generated from images taken twice per day, giving a resolution in longitude of about 7°. Interpolation was performed for short periods of missing data. The bright, square block at high southern latitudes on the right-hand side of the C1 plot is a result of bad data (Plate 3b).

The data for both the EIT and LASCO C1 were taken from a heliocentric height of 1.15R. The EIT off-limb map and the LASCO C1 map show a great deal of similarity. The most prominent feature of both maps is the bright active region (AR7986). As the emissivity of the green line peaks at 2 × 10^6 K, this is expected. The general morphology of the green line corona at 1.15R, shows high intensities on either side of the equator, separated by a lower intensity. This is particularly evident between longitudes of 0° and 180°. The green-line emission acts as a tracer of the closed coronal magnetic field lines. Thus the magnetic field is concentrated at midlatitudes in each hemisphere, indicating that the magnetic topology has higher order multipole components than just a simple dipole [Schwenn et al., 1997].

Note that the green line intensity is enhanced even up to 90° latitude. This is not because the closed coronal magnetic fields extend into the coronal holes. Rather, it is the result of a projection effect. If a streamer is bright at large distances from the Sun and is at high latitudes, a radial projection would result in it being visible over the polar holes, even when the feature is at central meridian.

Polar plumes are visible in the EIT off-limb maps as nearly horizontal streaks at latitudes greater than 45°. These features are very faint and as a result are easily obscured by high-latitude streamer structure.

3.2.2. UVCS. Synoptic maps of the corona in H Lyα and in O VI (1032 Å) from the Ultraviolet Coronagraph Spectrometer (UVCS) [Kohl et al., 1995] are shown in Plates 3c and 3d. These maps were generated from scans made with the UVCS spectrometer slits at 1.75 R. The slits are 40° long (tangent to the limb) and are scanned in height at 8 equally spaced posi-
Plate 1. Synoptic maps covering the period from CROT 1912/253° to 1913/45°, which corresponds to August 3 to September 15, 1996, at central meridian. Data for all maps taken from a N-S strip at central meridian: (a) intensity of photospheric magnetic field, (b) intensity of He II, (c) intensity of Fe IX–Fe X, and (d) intensity of Fe XII.
Plate 2. Synoptic maps covering the period from CROT 1912/253° to 1913/45°, which corresponds to August 3 to September 15, 1996, at central meridian. Data for all maps taken from a N-S strip at central meridian: (a) intensity of O V, (b) intensity of Mg IX, (c) intensity of soft X rays, and (d) intensity of 17-GHz microwaves.
Plate 3. Synoptic maps covering the period from CROT 1912/253° to 1913/45°, which corresponds to July 27 to September 8, 1996, at the east limb of the Sun. Data for all maps are taken from a semicircular annulus at the specified heliocentric height and solar limb: (a) intensity of Fe IX–Fe X at 1.15\(R_{\odot}\), (b) intensity of Fe XIV at 1.15\(R_{\odot}\), (c) intensity of O VI at 1.75\(R_{\odot}\), and (d) intensity of H I Ly\(\alpha\) at 1.75\(R_{\odot}\).
Plate 4. Synoptic maps covering the period from CROT 1912/253° to 1913/45°, which corresponds to July 27 to September 8, 1996, at the East limb of the Sun. Data for all maps are taken from a semicircular annulus at the specified heliocentric height and solar limb: (a) logarithm of intensity of polarized brightness (pB) at 1.75Rₜ, (b) logarithm of intensity of pB at 2.5Rₜ, (c) logarithm of intensity of pB at 5Rₜ, and (d) logarithm of intensity of pB at 2.5Rₜ on the west limb.
tion angles to cover 360° around the Sun. More details on how the UVCs synoptic maps are made can be found in the paper by Strachan et al. [1997].

The O VI intensity map is markedly different from the Lyα and white-light synoptic maps (see Plates 4a–4c and section 3.2.3). The streamer is very structured in O VI. At the longitudes which are approximately azimuthally symmetric, the brightest regions in O VI correspond to the edges of the streamer structure in Lyα. The likely reason the “legs” of the O VI streamer are brighter than the core of the streamer is because of a depletion of O+ in the streamer core [Raymond et al., 1997]. The depletion is not as apparent in the streamer close to the elephant’s trunk coronal hole because projection effects interfere. The deflection of the streamer belt means that rather than looking along the current sheet or streamer, we are instead looking through it; thus the edges are not distinct.

The Lyα intensity map shows a streamer structure very similar to that shown by the white light coronagraphs (Plates 4a–4c). The equatorial streamer belt is not tilted much and has a central maximum along the solar equator. This is discussed in the section on the white-light data (section 3.2.3).

Since UVCs has spectroscopic capabilities, it is also possible to make synoptic maps showing variations in line widths [Strachan et al., 1997]. The O VI (1032 Å) line widths, in particular, clearly show a correlation between broad line widths and open field regions as pointed out by Kohl et al. [1997] and Antonucci et al. [1997]. The broad profiles characteristic of open field regions even show up in equatorial coronal holes like the elephant’s trunk. This diagnostic allows one to discriminate between regions of density or abundance depletions and regions where large transverse motions are present. The line broadenings are most likely due to ion cyclotron resonance heating on open magnetic field lines [Crommer et al., 1997].

3.2.3. White-light data: MkIII, LASCO C2 and C3. The synoptic maps from Mauna Loa MkIII (Plate 4a), and the LASCO C2 and C3 telescopes (Plates 4b–4d) are all of intensities of polarized brightness. Using polarized brightness, particularly at low heights (below 5R_s), enables the F and K coronae to be separated because the F corona (zodiacal light) is largely unpolarized. The polarized brightness of the K corona arises from photospheric light scattered off of coronal electrons, and is proportional to the electron density along the line of sight (l.o.s.). At higher heights, the separation becomes more difficult because the polarization of the F corona becomes more significant. However, the solar features (i.e., the streamer belt) are still clearly visible out to 30R_s, the edge of the LASCO C3 field of view. The data plotted are taken once per day, so the longitude resolution is about 13°. Note, the southern hemisphere in the LASCO C3 map (Plate 4c) is dark because the southeast quadrant of C3 images is blocked by the pylon which holds the external occulter. Missing data in the LASCO maps appear as dark rectangles.

3.2.3.1. Streamer belt: The morphology of these solar minimum white-light synoptic maps is easily explained by the following, as has been pointed out by various authors [Vibert, Lamy, and Llebaria, 1997; Wang et al., 1997]. A single coronal streamer, which overlies a current sheet, encircles the Sun. The simplest state of the current sheet is to encircle the Sun at the equator. Any deflection or fold of the current sheet is reflected in the coronal streamers. Obstacles such as active regions and coronal holes cause the current sheet to be deflected. Any place where the l.o.s. through the current sheet is long, the synoptic maps are bright. Thus, when the current sheet is at the same latitude for a large range of longitudes, the synoptic maps are bright. This occurs when there are no obstacles causing a diversion of the current sheet, as on the azimuthally symmetric side of the Sun. However, the white-light intensities can also be high close to obstacles, though there are apparent discontinuities as well. Consider the case where the streamer belt is diverted southward to “avoid” the elephant’s trunk coronal hole. When the streamer belt is on the southward excursion it dims, or even seems to disappear. This is because the l.o.s. integration is very short, across the streamer belt, not along its length. The streamer belt then turns northward, to return to the solar equator. At the turn from south to north, the l.o.s. integration is enhanced and so the streamer appears bright in the data (see the MkIII data in particular). It then dims again on the northward journey.

3.2.3.2. Equatorial coronal holes: Although the data are from the limb, the above description shows why equatorial coronal holes are visible in the white-light coronal synoptic maps. Equatorial coronal holes are revealed by the deflections of the equatorial streamer belt. It has been shown that there are several equatorial coronal hole extensions on the Sun during the WSO Campaign [Zhao et al., 1997] (Figure 1). Using MDI and Wilcox Solar Observatory (WSO) data it was shown that there are open-footpoint field lines (interpreted here as coronal holes) extending from both the north and south polar holes. Figure 1 shows the results from two different modeling methods that vary in the assumptions used. There is a north-
ward extension from the south polar hole at about Carrington longitude 245° and the elephant’s trunk shows up as a southward extension from the northern coronal hole at about 295°. All of the results using the MDI data, though not the WSO data, also show an equatorial extension at about 25°. One model also shows a southward extension from the northern polar hole at about 345°, though this particular extension does not reach very low latitudes (see Figure 1 lower panel). It is obvious that the white-light maps all show evidence of a deflection of the streamer belt northward at about 245° to get around the northern extension of the southern polar hole. There are also southward deflections of the streamer belt evident, particularly in the LASCO C2 data, at both 295° and at 25°. These correspond with the locations of the southward extensions from the northern coronal hole shown in Figure 1. It is worth noting that there is no obvious counterpart to the southern extension of the northern polar hole at 345°. Because the Zhao et al. modeling did not show the extension reaching to low latitudes, the lack of evidence in the white light data is perhaps not surprising.

Note that except for the elephant’s trunk, none of the other equatorial coronal holes are easily discernible, if at all, in the CM maps shown here at indicating the presence of equatorial coronal holes. 3.2.3.3. Variation with height: Comparison of the white-light synoptic maps shows that at higher heights, the streamer belt becomes narrower. In addition, the deflections of the streamer belt do not reach latitudes as high as at lower heights. However, deflections of the streamer belt due to an equatorial coronal hole are evident out to at least 27 R°. The northward deflection of the streamer belt at Carrington Longitude 245° and the southward deflection at 295° are visible in the C3 west limb map shown in Figure 2.

3.2.3.4. East versus west: A comparison of the LASCO C2 synoptic maps from the east and west limbs (Plates 4b and 4d) shows large differences in the appearance of the streamer belt. An inspection of the synoptic maps from a particular limb for several rotations shows very little variation (as noted for SXT in section 3.1.3). Because of this, the differences in the east and west limb maps are unlikely to be due to morphological changes of the solar corona. The tilt of the Sun we believe accounts for these differences. In order to explain the differences in the maps, note that the equatorial coronal holes are not evident in the same way in both maps. The tilt of the Sun means that on the west limb, the dim (low-density) coronal hole is hidden because the l.o.s. is more highly aligned along the length of the streamer belt, which is also tilted in a N-S direction. When the elephant’s trunk has rotated around to the east limb, the tilt of the Sun means that the l.o.s. is no longer along the tilted streamer belt, but across it. So the low l.o.s. density region which corresponds to the location of the elephant’s trunk is apparent as a break in the streamer. Wang et al. [1997] have used a streamer belt model to show that this is a reasonable interpretation of the data.

4. Conclusions

We have shown that synoptic maps at different wavelengths provide important information on the morphology of the solar corona. The characteristics of on-disk data synoptic maps are very different from those of limb data maps. However, features such as equatorial coronal holes are evident in both. The on-disk maps show that magnetic dipole features are bright at all of the wavelengths shown. However, the equatorial coronal hole is most obvious in the data from higher altitudes than the data from low altitudes. The MDI data show that even at solar minimum, the magnetic picture is complicated by the presence of two solar cycles. The coronal holes do not show up well at the coolest temperatures (below ~1 MK) or lowest altitudes. The microwave data show filaments, which the other maps are unable to do. The limb synoptic maps from MkIII, LASCO C2, and LASCO C3 show that the Sun is encircled by a single streamer belt. The streamer is deflected from its path along the equator by equatorial coronal holes. Deflections of the streamer belt are good indicators of the presence of equatorial coronal holes and some deflections of the streamer are evident out to at least 27 R°. The EIT and LASCO C1 iron line synoptic maps show a more complicated multipolar structure to the magnetic fields at 1.15R°. The O VI map presents a very different, bright legs/dark core picture, most likely due to depletion of O+ in the streamer core. Finally, the difference in the appearance of the east and west limbs are ascribed only to the tilt of the Sun.

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