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SYNOPTIC STUDY OF THE CORONA AT METER WAVELENGTH

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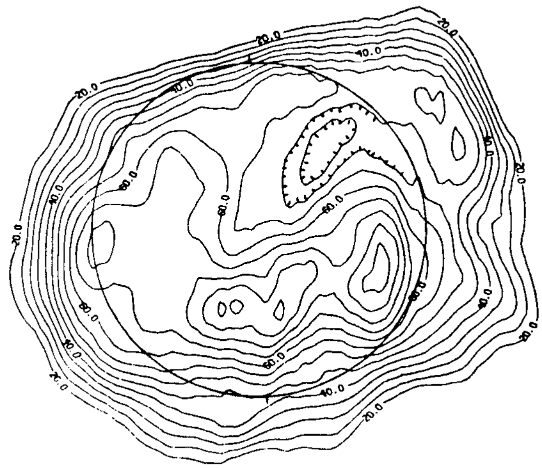
The Mark III Nançay Radioheliograph (Radioheliograph Group, 1983) is used to observe the Sun at 169 MHz (λ=1.77 meter) with a time resolution of 25 East-West and North-South images per second. When the brightness distribution of the Sun is stable during the eight hours of daily observation, a two dimensional map can be produced using the technique of earth rotation synthesis (Alissandrakis et al.,1985). The best images are obtained during the period April-August, when the declination of the Sun is high to give a good coverage in the uv plane and a reasonable North-South resolution. The spatial resolution is 1.5' East-West and, in summer, 3.5' North-South (half power beam width). The maps are calibrated using Cygnus A as reference.

An example of a radio map is shown in Figure 1. A large coronal hole is observed as a depression (hatched contours) in the North-West quadrant. Its brightness temperature is 400-500,000 K. This value is to be compared with the quiet sun brightness temperature of about 600-700,000k in North-East quadrant. Bright sources in the southern hemisphere are nonthermal noise storm continua and bright arch systems (Alissandrakis et al.,1985).

On the disk the meter wavelength emission originates from the low corona with contribution from the chromosphere-corona transition region. On the limb, the corona is observed at higher altitude with integration along line of sight. To summarize the daily maps over the entire solar surface, synoptic charts are plotted after a Mercator projection, either on the disk or on the limb. Because of the radio center to limb effect, the data are limited, on the disk, to the regions close to central meridian, taking into



Solar map at 169 MHz, on july 15,1984 with the Nançay Radioheliograph. Contours are brightness temperature labelled in 10^4 K units.

account a weighting function. On the limb, a synoptic chart is deduced from brightness temperature at a given altitude around the Sun. For the same days two synoptic charts are plotted, one from the east limb data and the other from west limb data. The synoptic charts facilitate comparison with observations at other wavelengths.

An example of comparison of disk synoptic charts is given in Figure 2: Figure 2a represents NOAA Boulder synoptic chart (Solar Geophysical Data Report,1984) deduced from Hα, Helium I and magnetic field daily observations. Coronal holes in Helium I (λ=10830 A°) are hatched contours. On radio synoptic chart 2b, very low brightness temperatures between Carrington longitudes (CR) 180°and 300°in southern hemisphere correspond to a large He I coronal hole. A northern coronal hole (CL 0-90°) is visible as a depression on radio chart. Because of the presence of noise storms (dashed area) the southern part of this hole is not observed at meter wavelengths.

Noise storm continua are related to active regions with sunspots (black points). They are in general not located directly above the active region but displaced by a few arc minutes, as pointed out by LeSqueren,1963 Active regions themselves do not emit at radio wavelength because of high density in active region loops. This agrees with X ray measurements which

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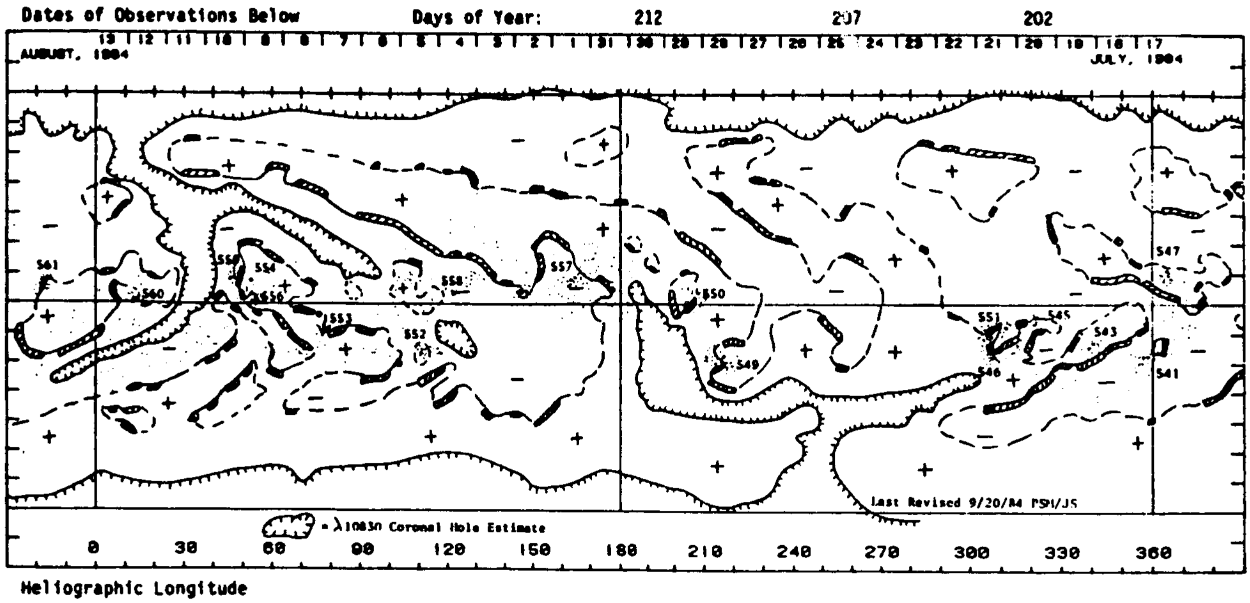

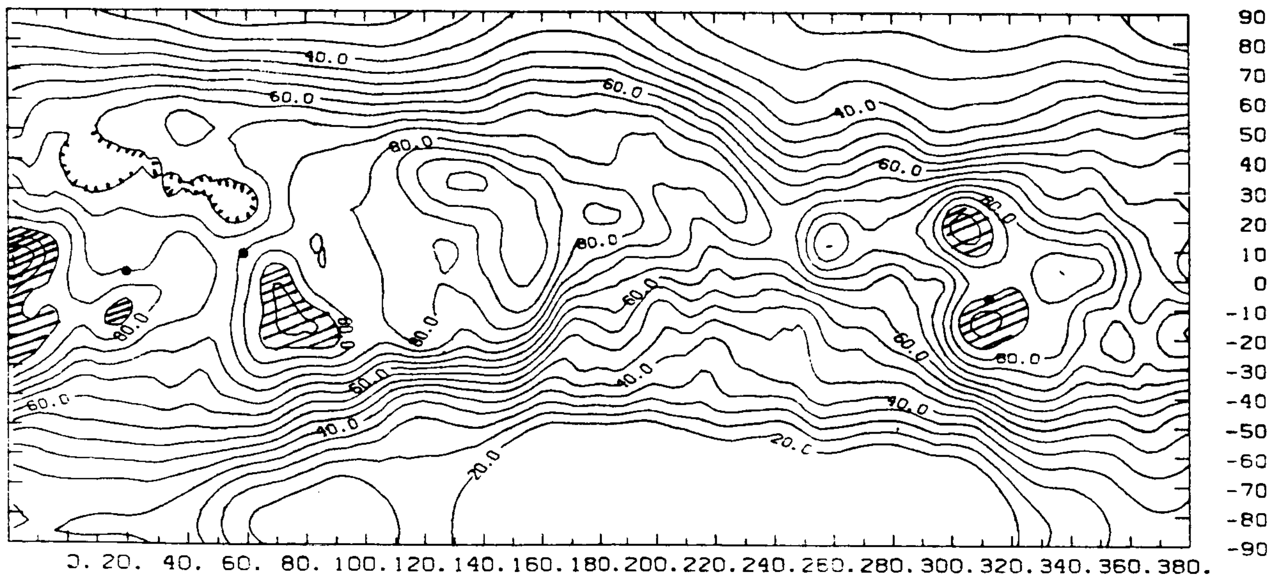

Figure 2

Comparison of synoptic chats on the disk for Carrington Rotation 1751

2a- Boulder synoptic chart

2b- Nançay synoptic chart (unit=10^4 K)

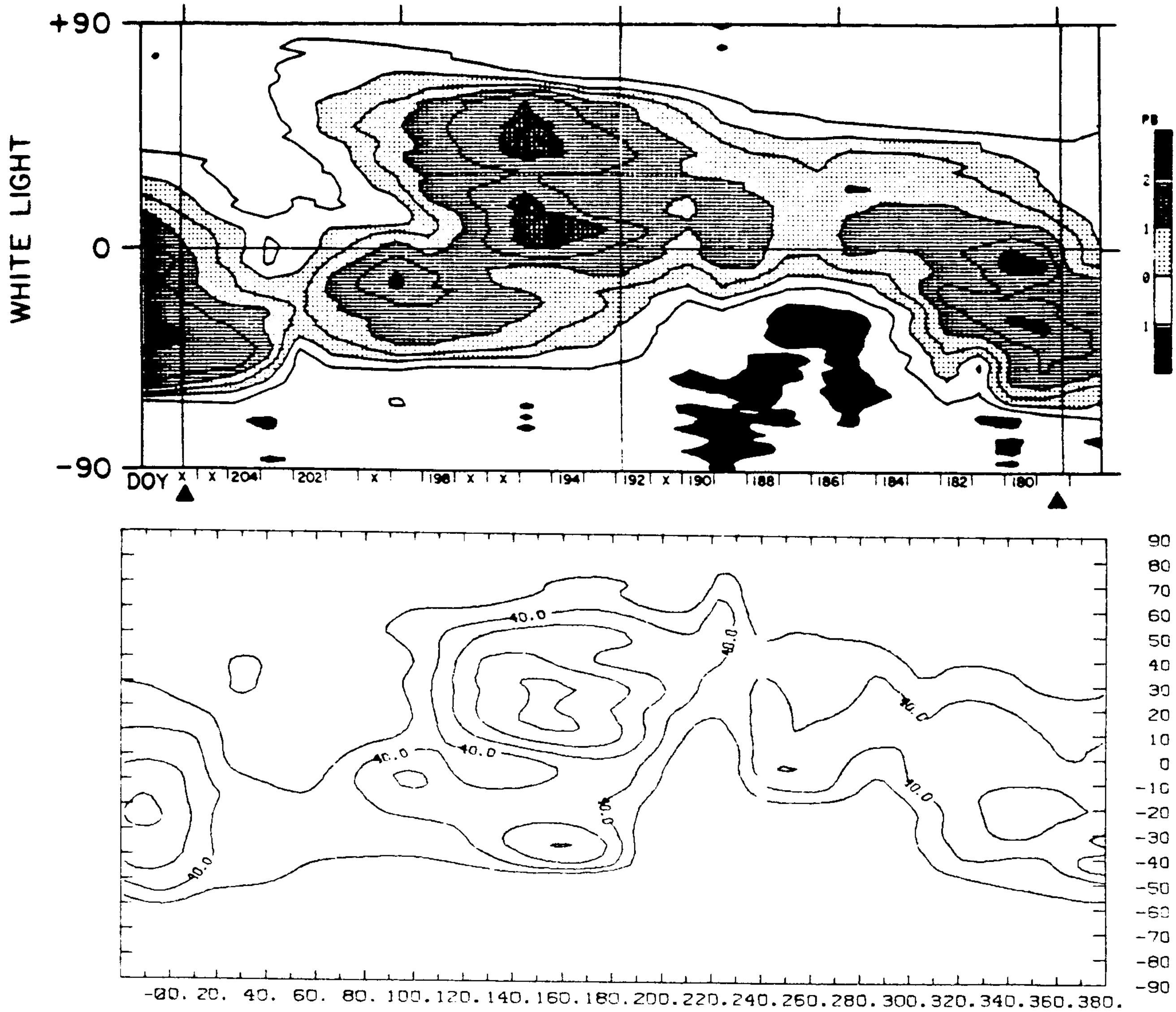

Figure 3

Comparison of synoptic charts on the limb for Carrington Rotation 1750

3a- Chart on the west limb with HAO Mark III K-coronameter.

3b- Chart with Nançay Radioheliograph at 169 MHz for the same limb (unit=10^4 K) gives densities of the order of 10^9 cm^{-3} (Davies and Krieger,1982) while density limit for wave propagation at 169 MHz is 3.5 10^8 cm^{-3}.

The other radio sources are generally located close to inversion line of longitudinal magnetic field. Sometimes they are related to Hα filaments (as suggested by Axisa et al.,1973), and sometimes not. Only 10% of Hα filaments of the Boulder or Meudon synoptic charts are associated with meter wavelength enhancements, while 60% are not related to localized sources brighter than 50,000K above the quiet regions. The remaining 30% are ambiguous because of noise storms in the vicinity.

Figure 3 represents a comparison of limb synoptic charts obtained with the HAO Mark III K-coronometer (3a) and with the Nançay Radioheliograph (3b) both produced for a distance of 1.3 solar radius. The high density region oscillating between southern and northern hemispheres is well observed on both charts. At higher altitude, it gives rise to the heliosheet which separates interplanetary sectors. As K-corona is only sensitive to electron density while radio brightness is sensitive to both density and temperature, a detailed comparison of both observations opens a new method of coronal temperature diagnostic.

REFERENCES

Alissandrakis C.E., Lantos P., Nicolaïdis E.,1985, Solar Physics 97,267

Axisa F., Avignon Y., Martres M.J., Pick M., Simon P., 1971, Solar Physics 19,110

Davis J.M., Krieger A.S.,1982, Solar Physics 80,295

Le Squeren A.M., 1963, Annales d'Astrophysique, 29,171

Radioheliograph Group, 1983, Solar Physics 88, 383

Sime D.G., Fisher R.R., Altrock R.C.,1985, NCAR Technical Note 251

Solar Geophysical Data Report n°481, NOAA, Boulder,1984