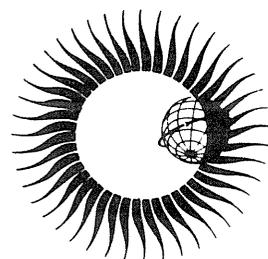


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for
Solar-Terrestrial Physics**



**SYNOPTIC SOLAR MAGNETIC FIELD MAPS
FOR THE INTERVAL
INCLUDING CARRINGTON ROTATIONS 1601-1680
MAY 5, 1973-APRIL 26, 1979**



August 1980

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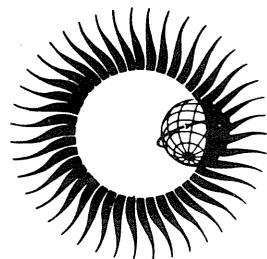
REPORT UAG-77

SYNOPTIC SOLAR MAGNETIC FIELD MAPS FOR THE INTERVAL INCLUDING CARRINGTON ROTATIONS 1601-1680 MAY 5, 1973-APRIL 26, 1979

by

J. Harvey, B. Gillespie, P. Miedaner and C. Slaughter
Kitt Peak National Observatory
Tucson, Arizona 85726, USA

August 1980

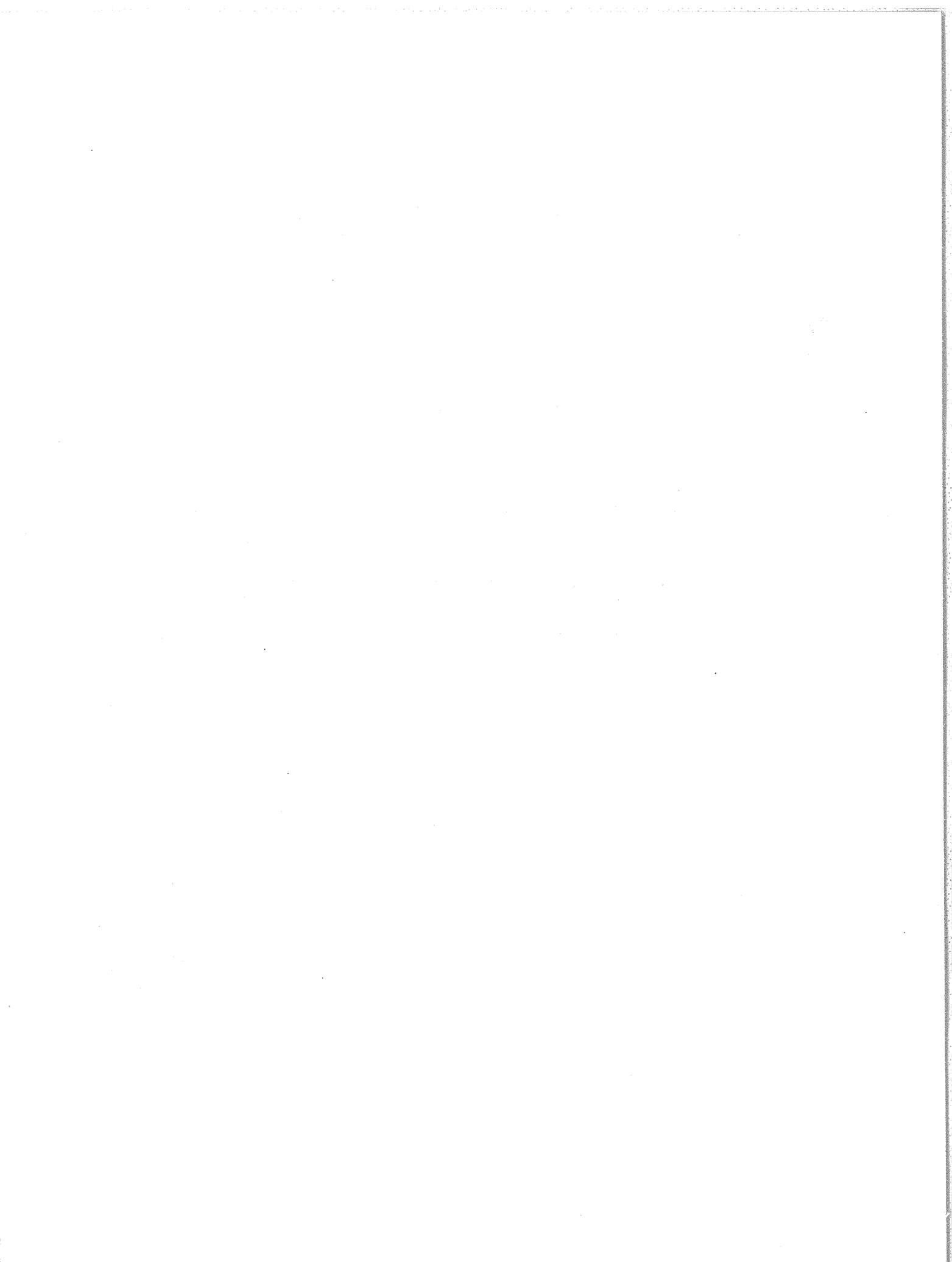


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Synoptic Solar Magnetic Field Maps for
the Interval Including Carrington Rotations 1601-1680

by

J. Harvey, B. Gillespie, P. Miedaner* and C. Slaughter
Kitt Peak National Observatory**
Tucson, Arizona 85726 USA

Introduction

A program of regular observations of solar magnetic fields was started at Kitt Peak National Observatory in April 1973, primarily in response to the needs of the Skylab mission. At first, the observations were made with the 40-channel magnetograph at the McMath telescope [Livingston and Harvey, 1971; Livingston et al., 1971]. During 1973 a telescope dedicated to synoptic studies was completed [Livingston et al., 1976a], and starting in 1974, observations were made with a 512-channel magnetograph [Livingston et al., 1976b].

Daily full disk observations were first combined into synoptic maps during the Skylab Solar Workshop on Coronal Holes and High Speed Wind Streams and were used for studies of the magnetic field strength below coronal holes [e.g., Bohlin and Sheeley, 1978] and extrapolations of the magnetic field into the corona [e.g., Levine, 1977], but these maps have never been published.

Starting with Carrington rotation number 1681 the synoptic maps have been produced and published regularly in *Solar-Geophysical Data, Part I* (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colorado). Old data obtained prior to Carrington rotation number 1681 have now been processed into synoptic maps in the same way as current data are processed, and this publication presents these earlier maps in the same format.

Mapmaking

In rough outline the synoptic maps are made in three steps: First, each daily observation is transformed into a Carrington coordinate system. Second, after a sequence of days covering one rotation (plus extensions on each end) is available, the daily maps are merged into a final map which represents the entire solar surface. Third, the arrays of numbers representing the maps are converted to gray-scale pictures with a precision cathode-ray-tube camera.

The transformation of a single observation to Carrington coordinates consists of several steps. First, the limb is located in the array of recorded intensity data as those points which have an intensity roughly one-quarter of the intensity of the disk center. To exclude clouds and sunspots, only points close to the expected position of the limb are processed. In the case of the 40-channel observations, the coordinates of the center of the disk are then determined by fitting a circle to the measured limb position of each of 21 swaths of recorded data. This information together with knowledge of the position angle of the solar rotation axis with respect to the scan direction (P angle), allows us to calculate the latitude and meridian distance of any observed point using well-known relations [Smart, 1960]. In the case of the 512-channel observations, variations in magnification and scanning parameters generally produce a slightly elliptical image, and we fit an ellipse to all of the measured limb positions rather than fitting one swath at a time. The latitude and meridian distance are computed using the same relations as for the 40-channel observations. However, we compute these coordinates only for every fourth point in the scan direction and fourth point perpendicular to the scan direction in order to substantially reduce the computing time without introducing significant position errors for observed points close to the one for which the coordinates are actually computed.

We use the approximate mean time of the observation to compute the Carrington longitude of the central meridian, and this value is added to meridian distances to derive Carrington longitudes of observed points. Three arrays of 180 by 180 elements are set up corresponding to one-degree increments in Carrington longitude and $1/90$ in the sine of the latitude. One array is used to accumulate measured values of longitudinal magnetic field. A second array accumulates the absolute value of the longitudinal field measurements. The third array accumulates the number of measurements obtained for each element. These three arrays are recorded on magnetic tape and maintained indefinitely in the observatory archives.

When a sufficient number of daily observations are available to cover a single Carrington rotation (27 days plus 3 or 4 days at each end) and have been processed as just described, they are merged. The merge starts by setting up three arrays of 360 longitude elements by 180 sine latitude elements which cover the entire solar surface in equal area increments. Instead of simply adding the daily 180 by 180 arrays to the final arrays, we apply a weighting function which was determined empirically to allow some averaging of one day with another to improve the statistics of the data but not to allow averaging of too many days together. If too many days' data are averaged, proper motions and evolution smear the spatial structure excessively. The weighting function we use is $\cos^4 \lambda$ where λ is the central meridian distance. Since the number of observations which fall in each longitude and latitude element is roughly proportional to $\cos \lambda \cos \phi$, where ϕ is the latitude, a net weighting function approximately proportional to $\cos^5 \lambda \cos \phi$ applies to each daily observation.

*Now operating Penelope's Restaurant, Tucson, AZ.

**Operated by the Association of Universities for Research in Astronomy, Inc. under contract with the National Science Foundation.

After one full rotation is merged, the resulting arrays are recorded on magnetic tape and maintained indefinitely in the observatory archives for visitor and staff research purposes. The arrays are converted to gray scale pictures by photographing a precision cathode-ray-tube display of the data on 70-mm film.

The photographs reproduced here show two versions of the data. The display labeled "Flux" is the mean measured magnetic field (weighted as described above) arranged to saturate at full white for a field strength of + 128 gauss and at full black for a field strength of - 128 gauss. Positive means the field is directed toward the observer. The gray scale is intended to be linear for mean field strength values between the saturation values.

The display labeled "Polarity" is the ratio of the weighted sum of the measurements to the weighted sum of the absolute value of the measurements and, therefore, ranges between values of +1 to -1. Full white means all of the measurements in an element were of positive polarity while full black represents entirely negative polarity measurements. Various shades of gray represent mixtures of polarities.

The gray scale displays are annotated with latitude and longitude ticks. Longer ticks with dates appended indicate the central meridian longitude at the time the various observations were made (usually around 1500 UT). If no data are available, black is left in the display.

Acknowledgments

During the interval covered by these data, the observational program was managed by B. Gillespie, who made most of the observations. Other observers, in addition to the authors, were J. Busman, L. Doe, D. Johnson, W. Livingston, F. Recely, and S. P. Worden. The observational program is supported in part by the Space Environment Laboratory, ERL, National Oceanic and Atmospheric Administration by stationing an observer at Kitt Peak. This essential support is gratefully acknowledged.

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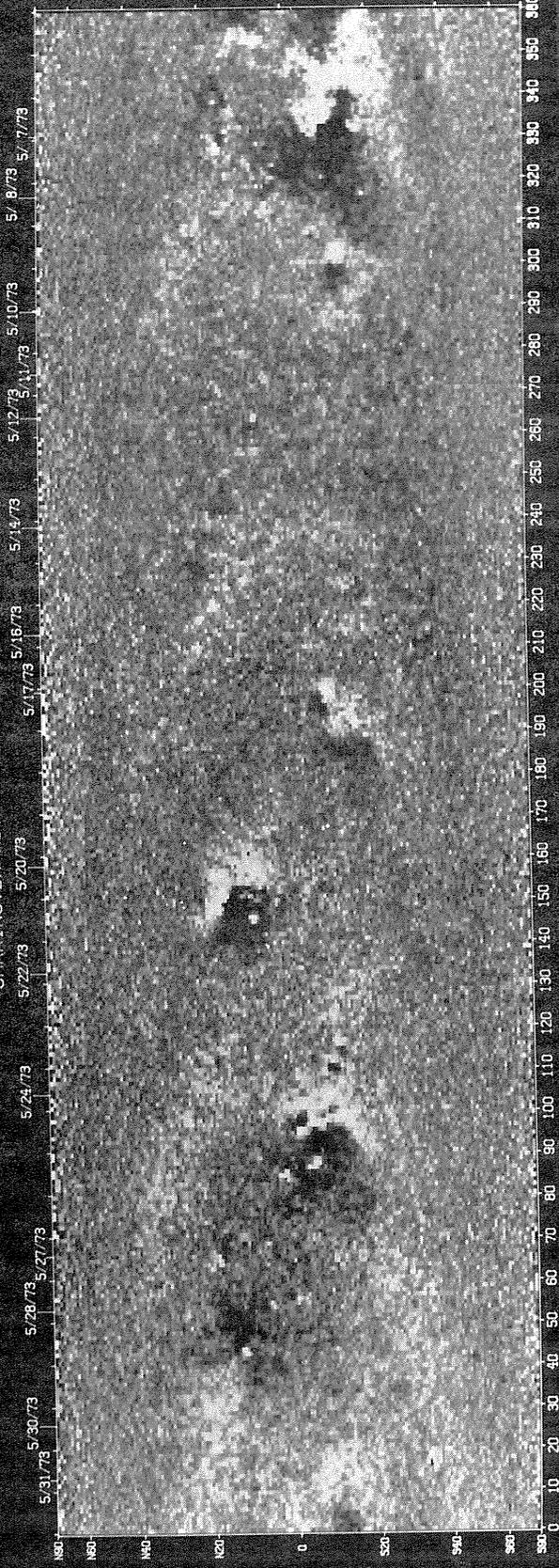
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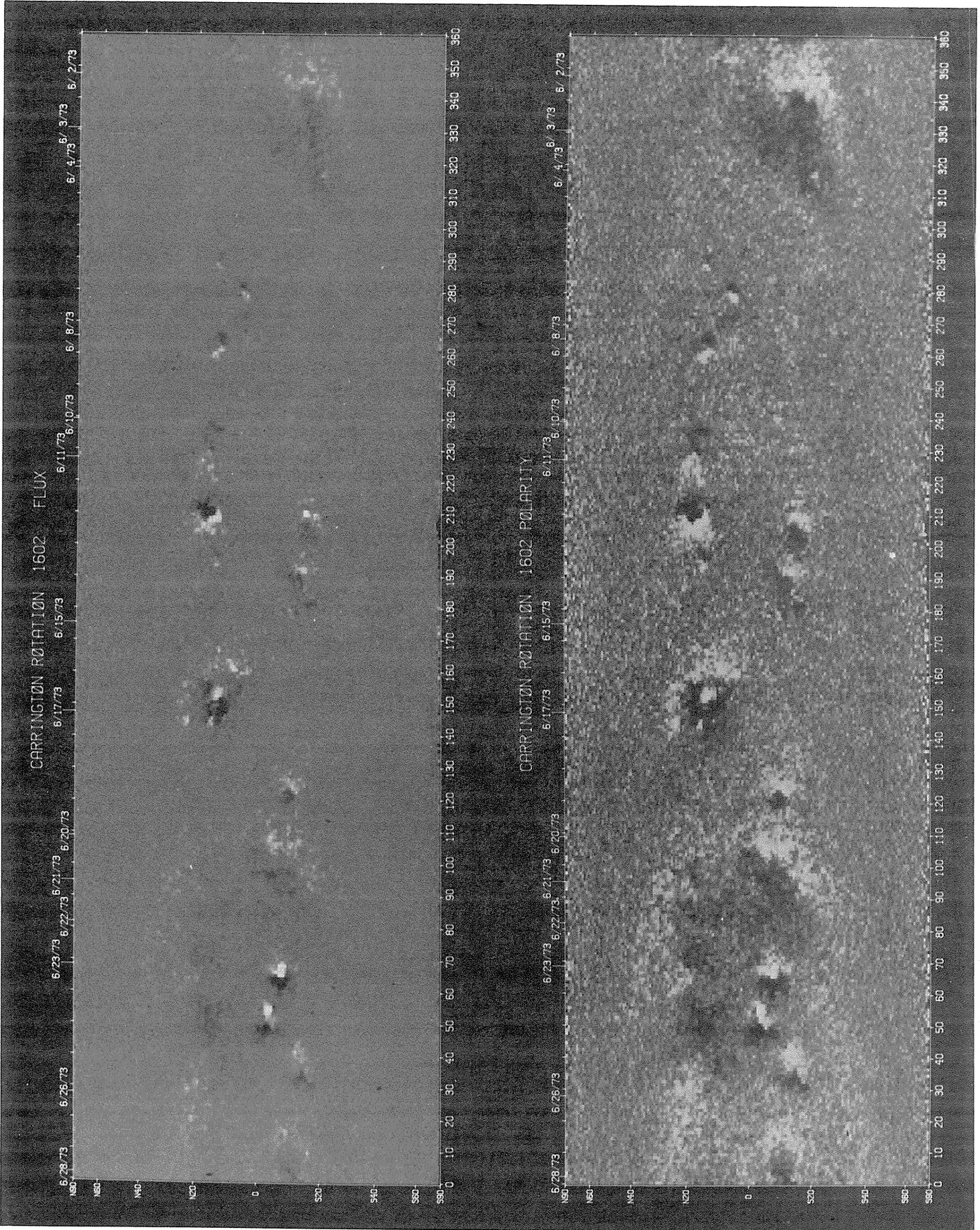
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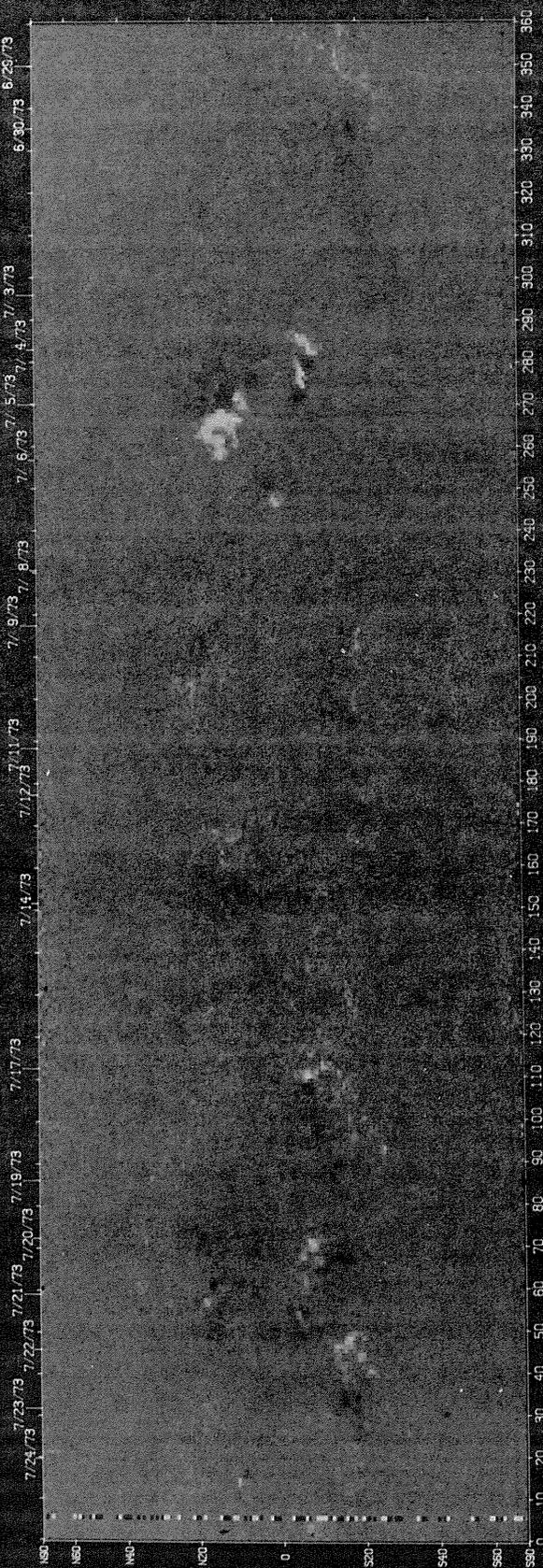


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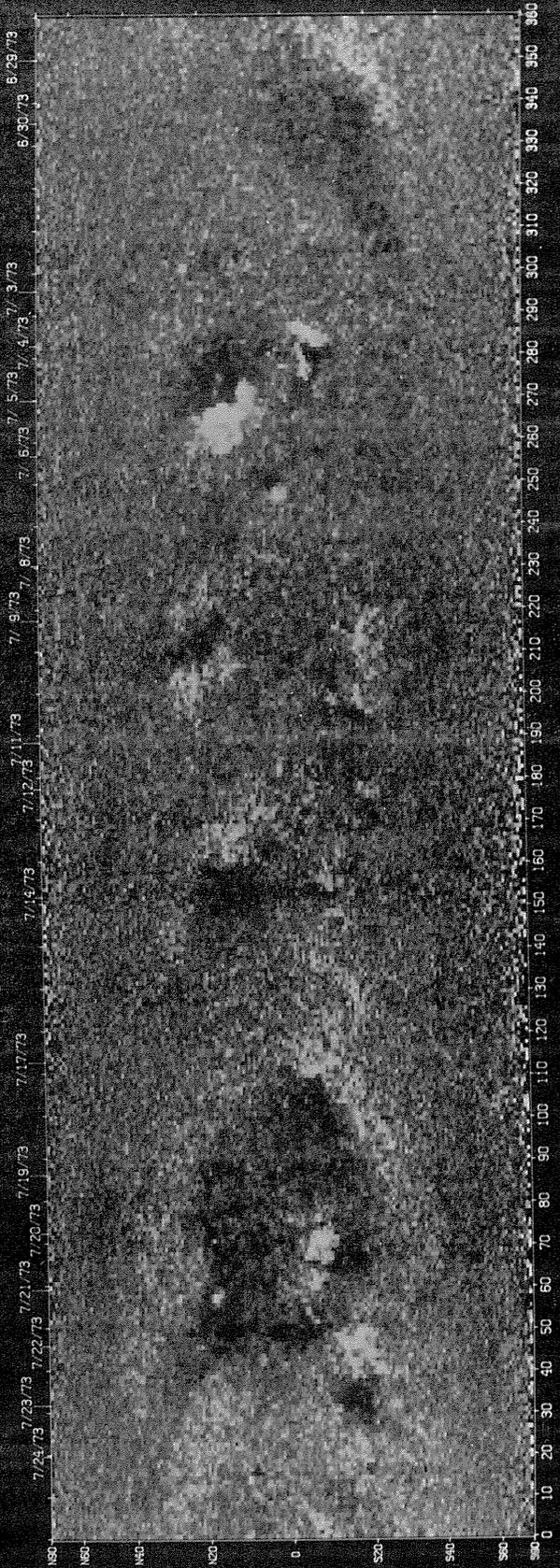


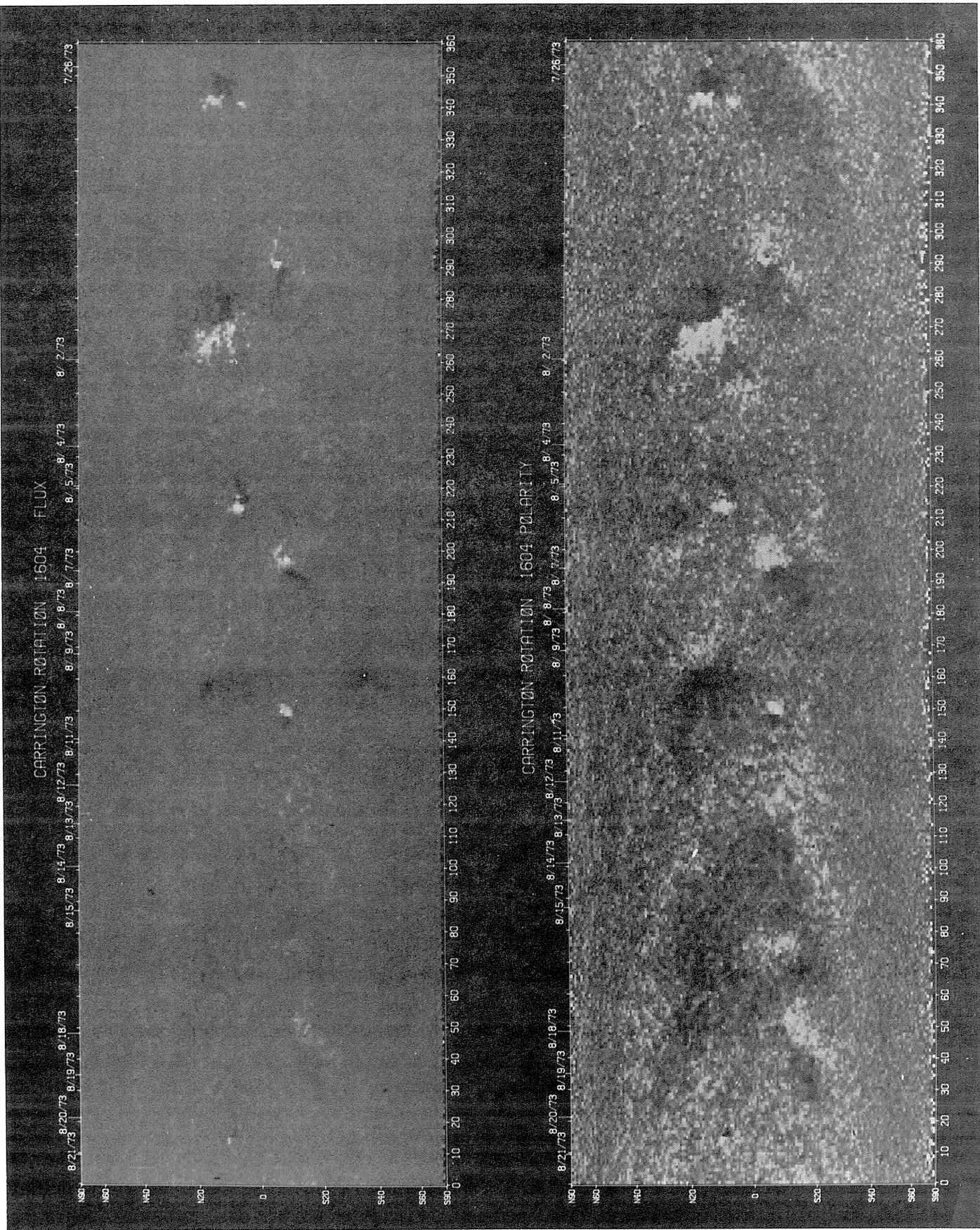


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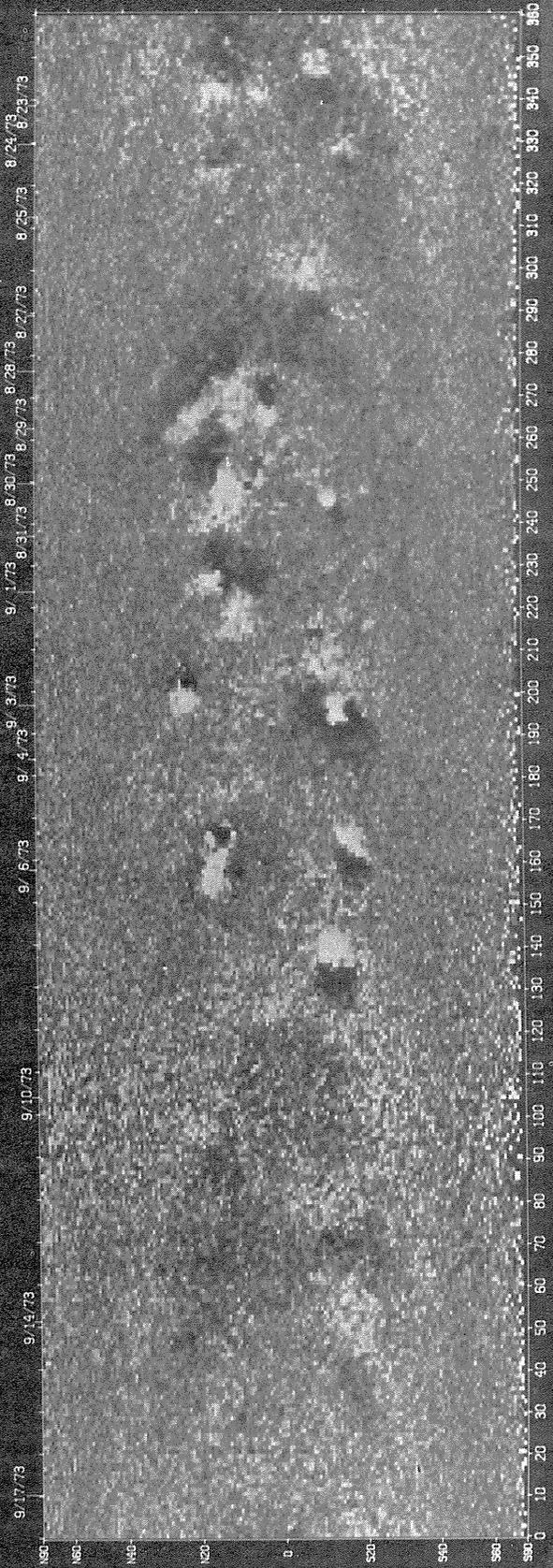


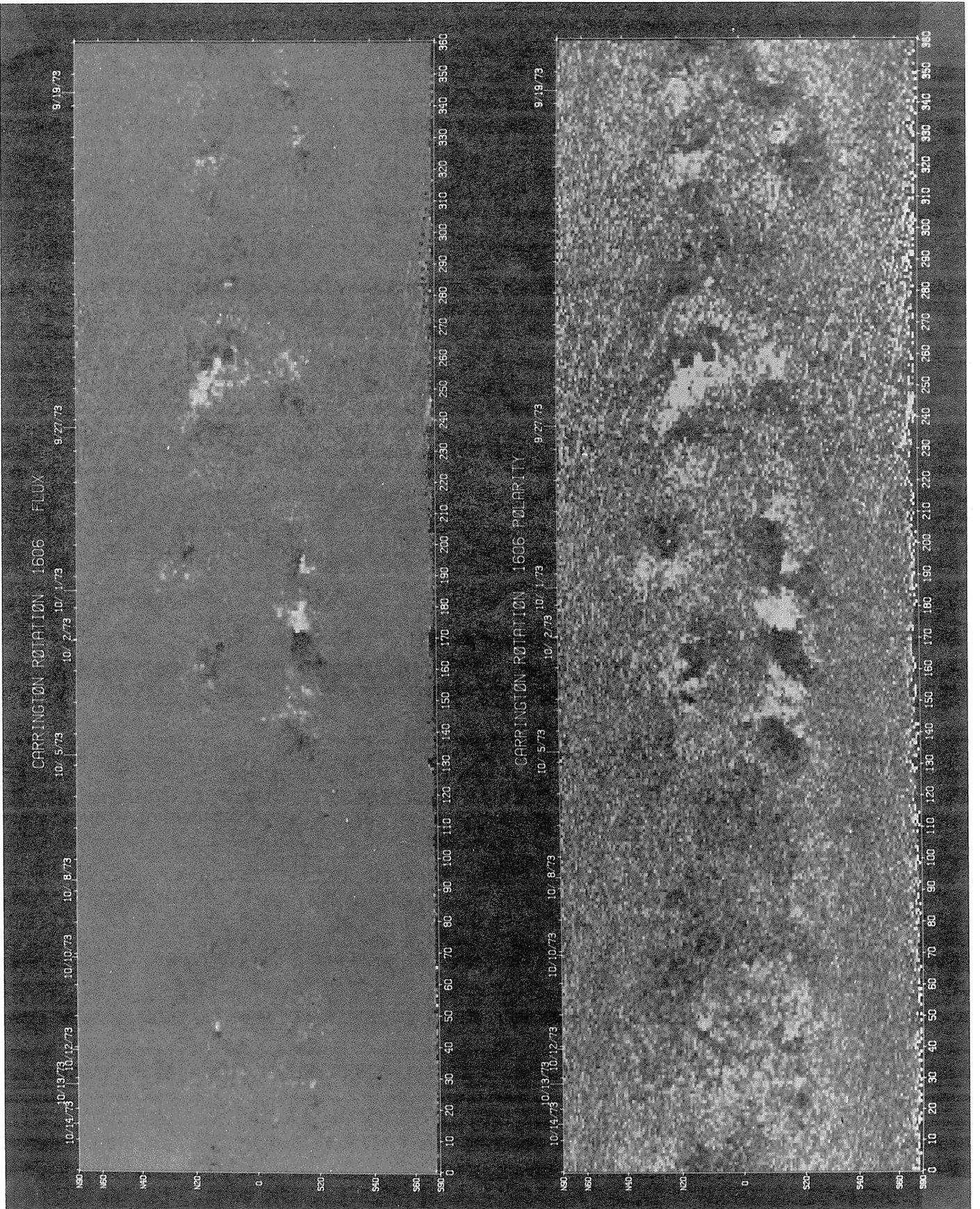


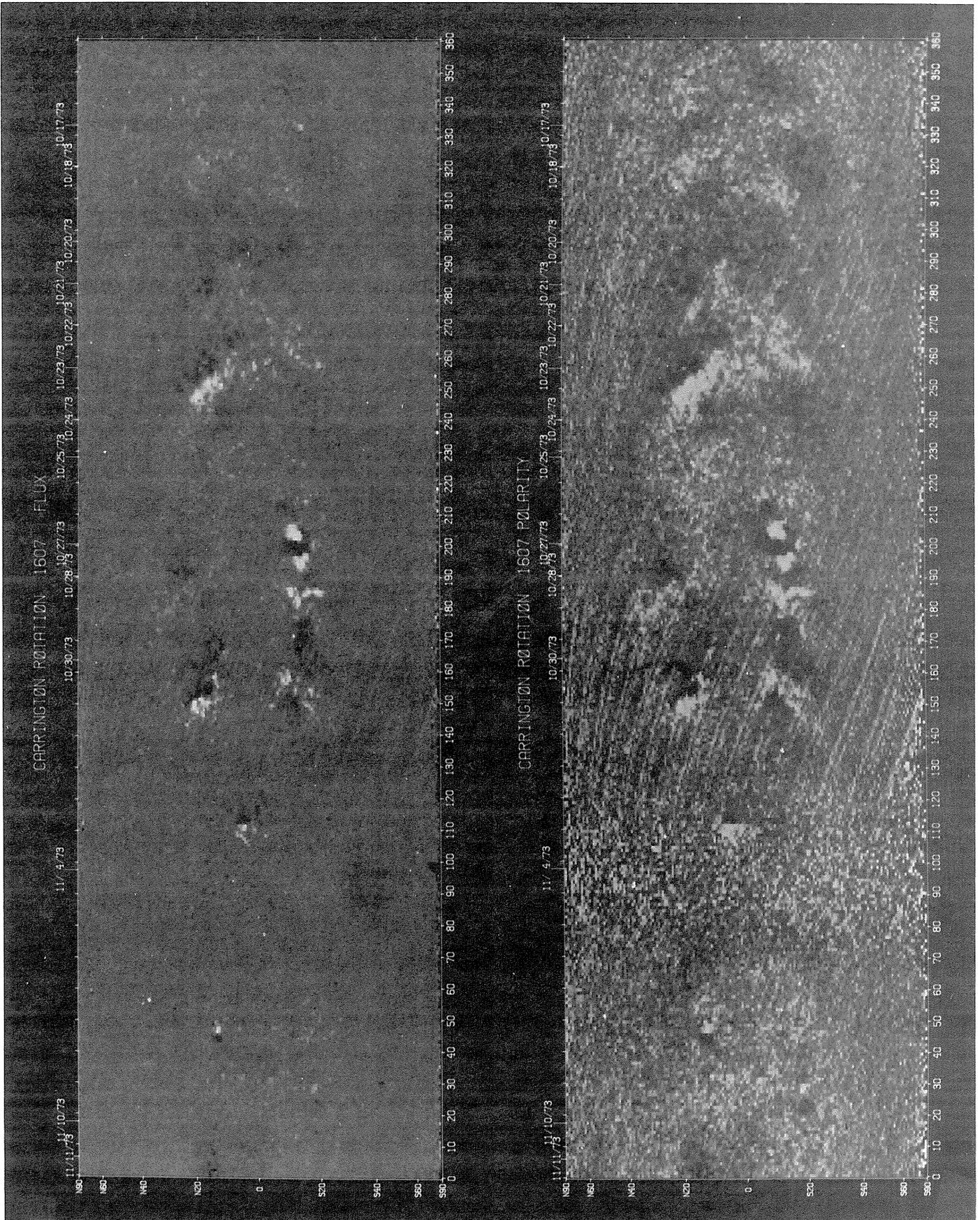
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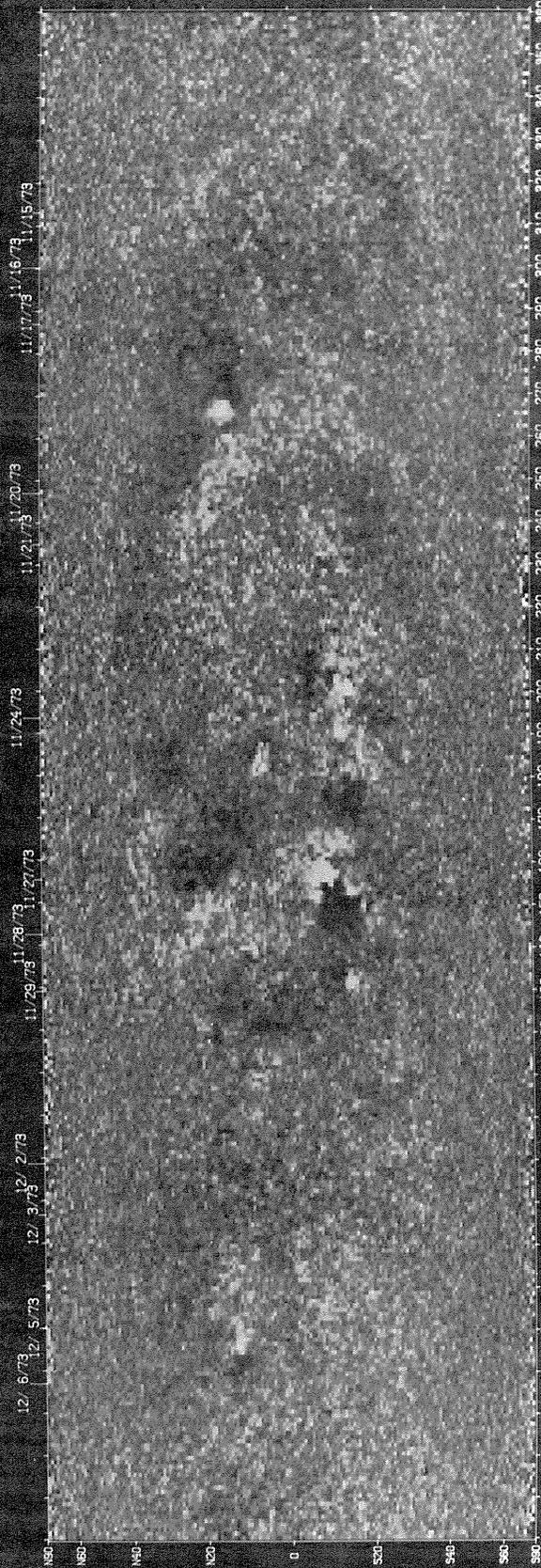


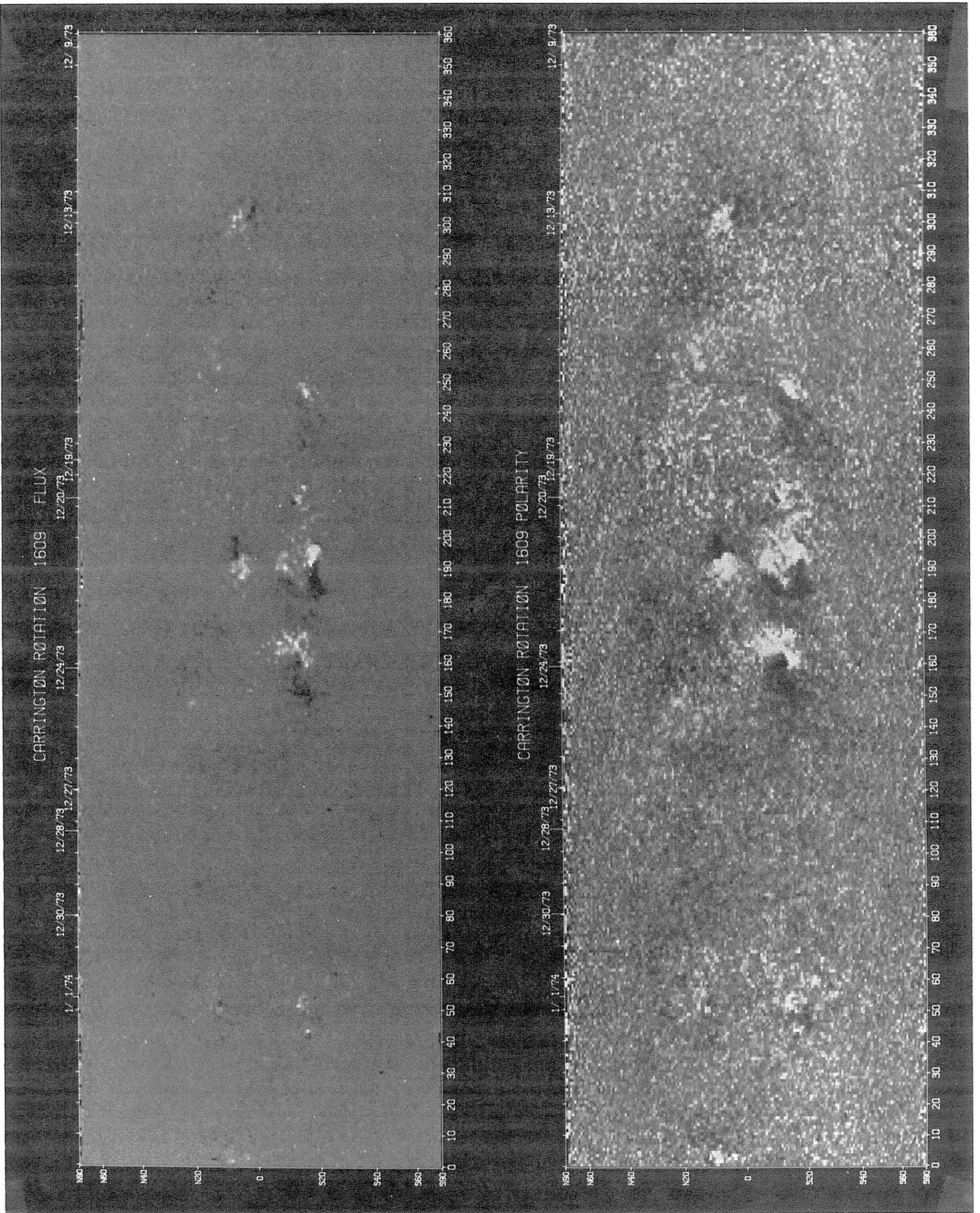


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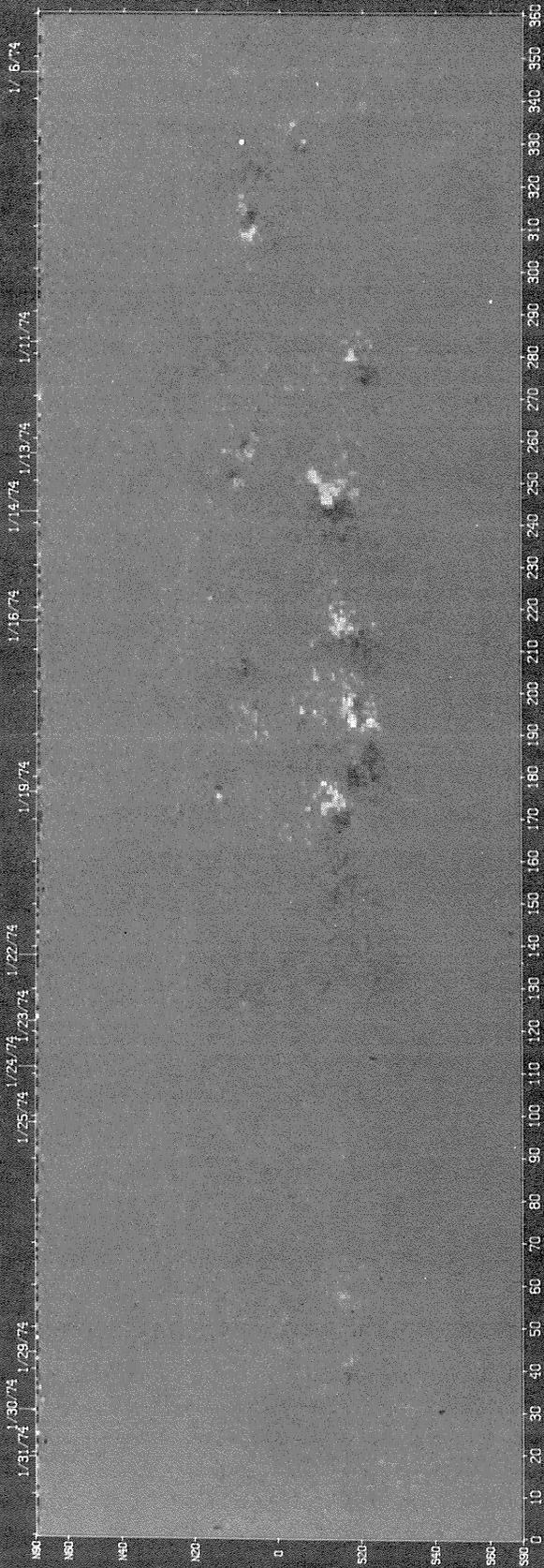


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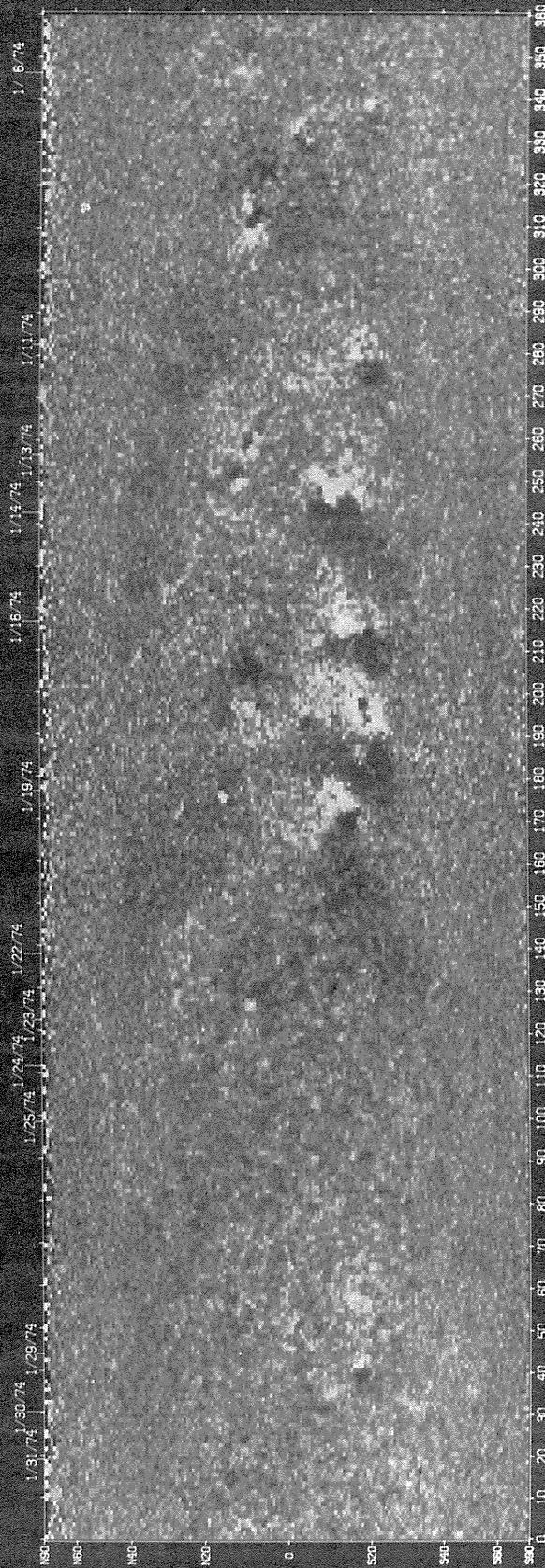


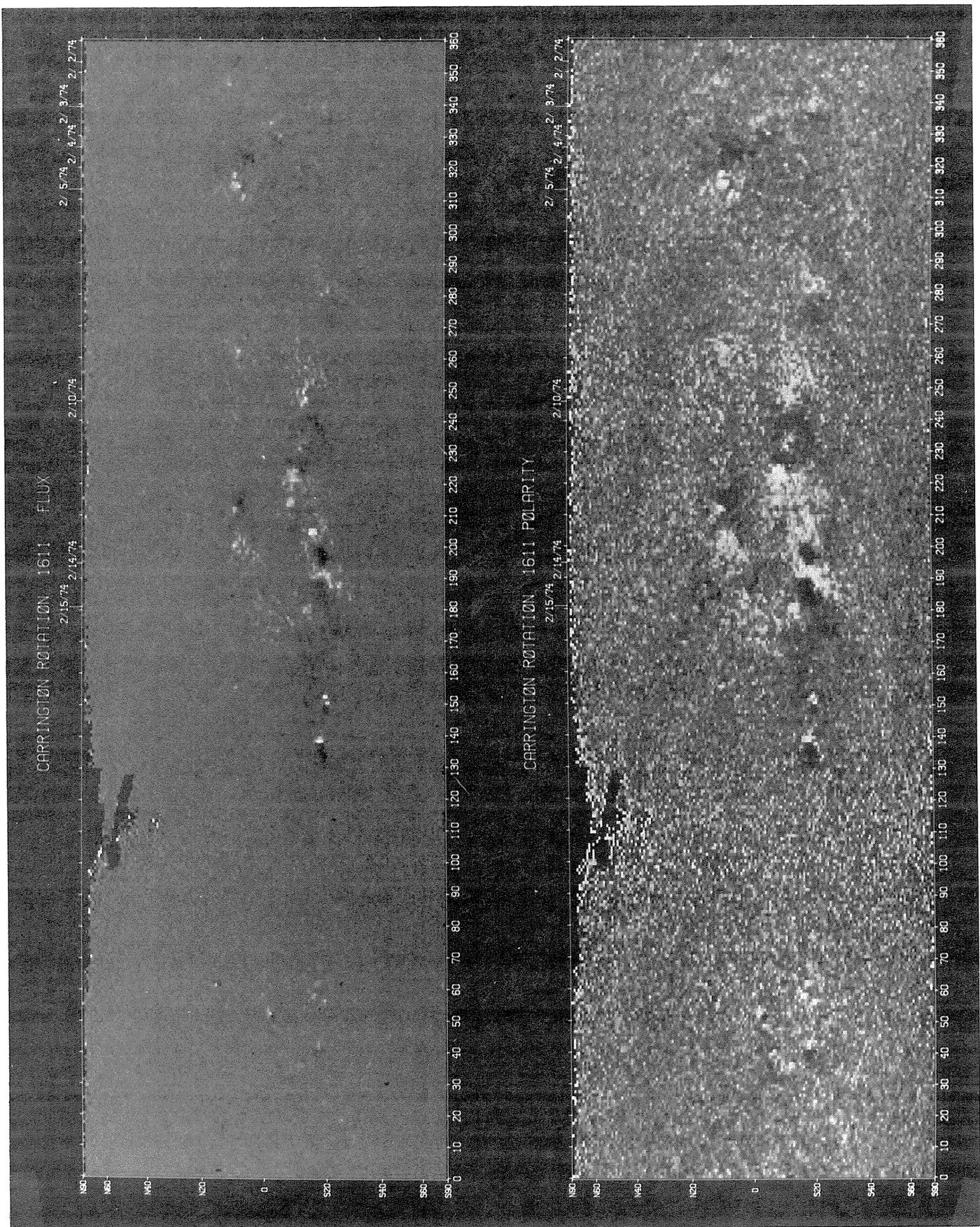


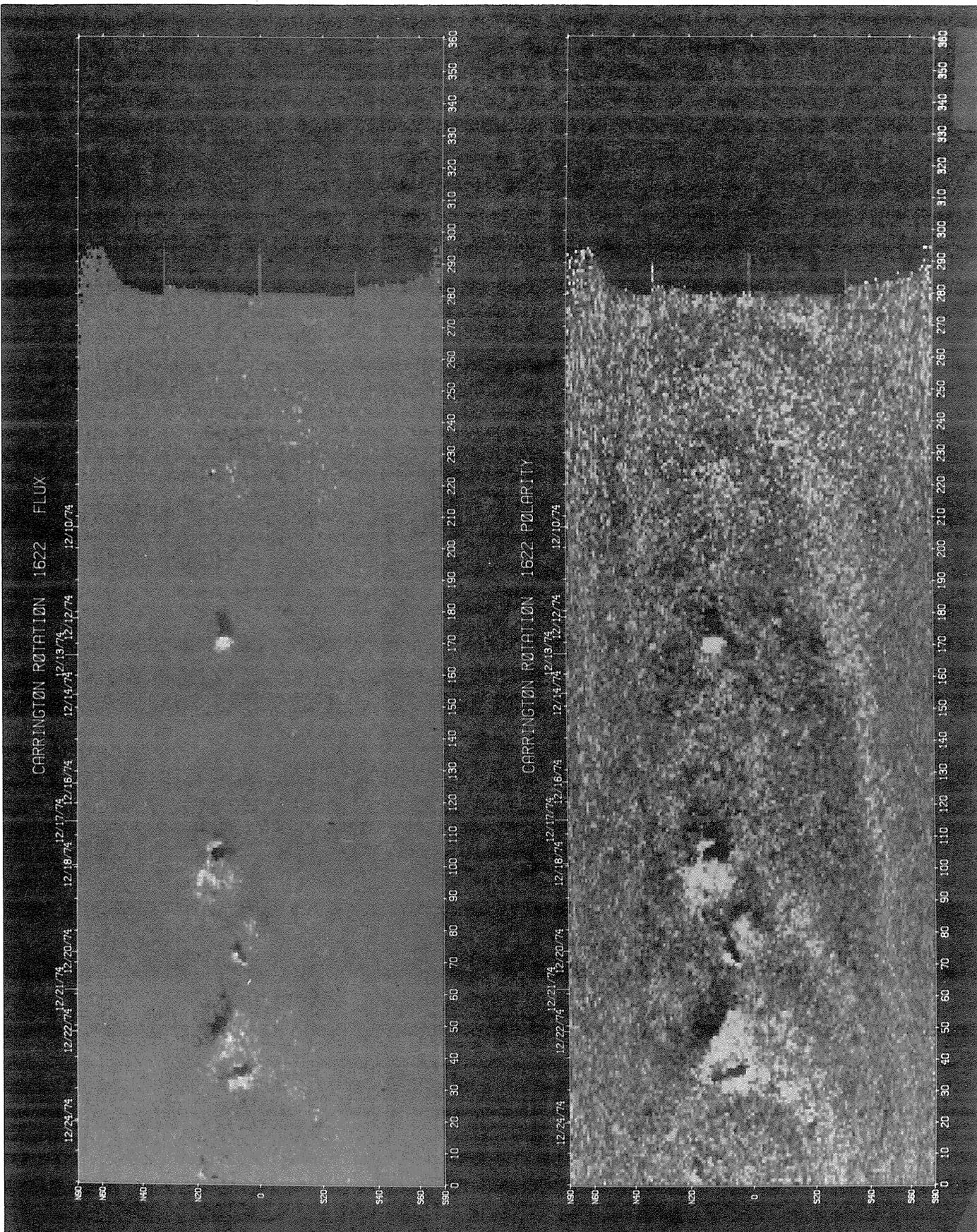
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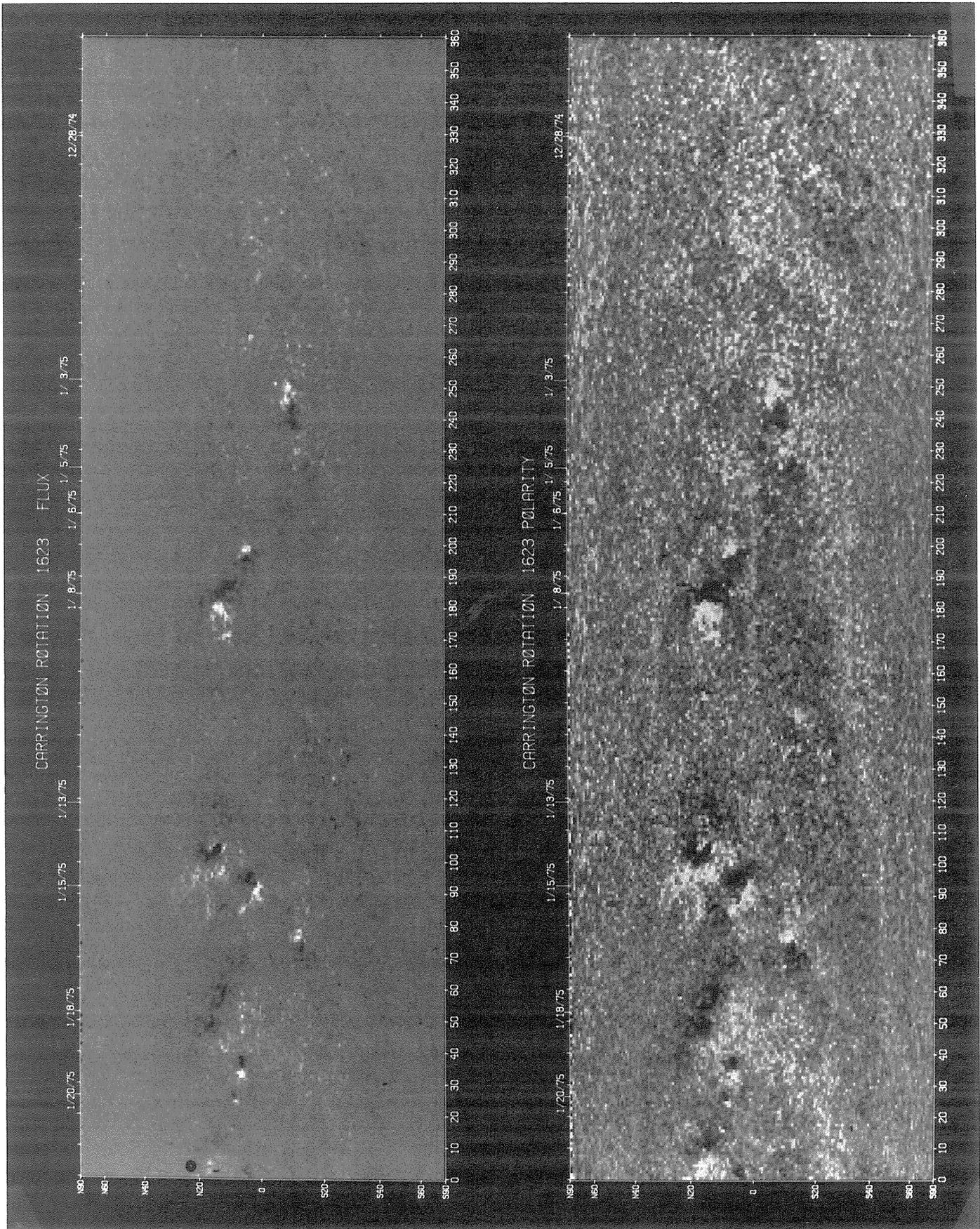


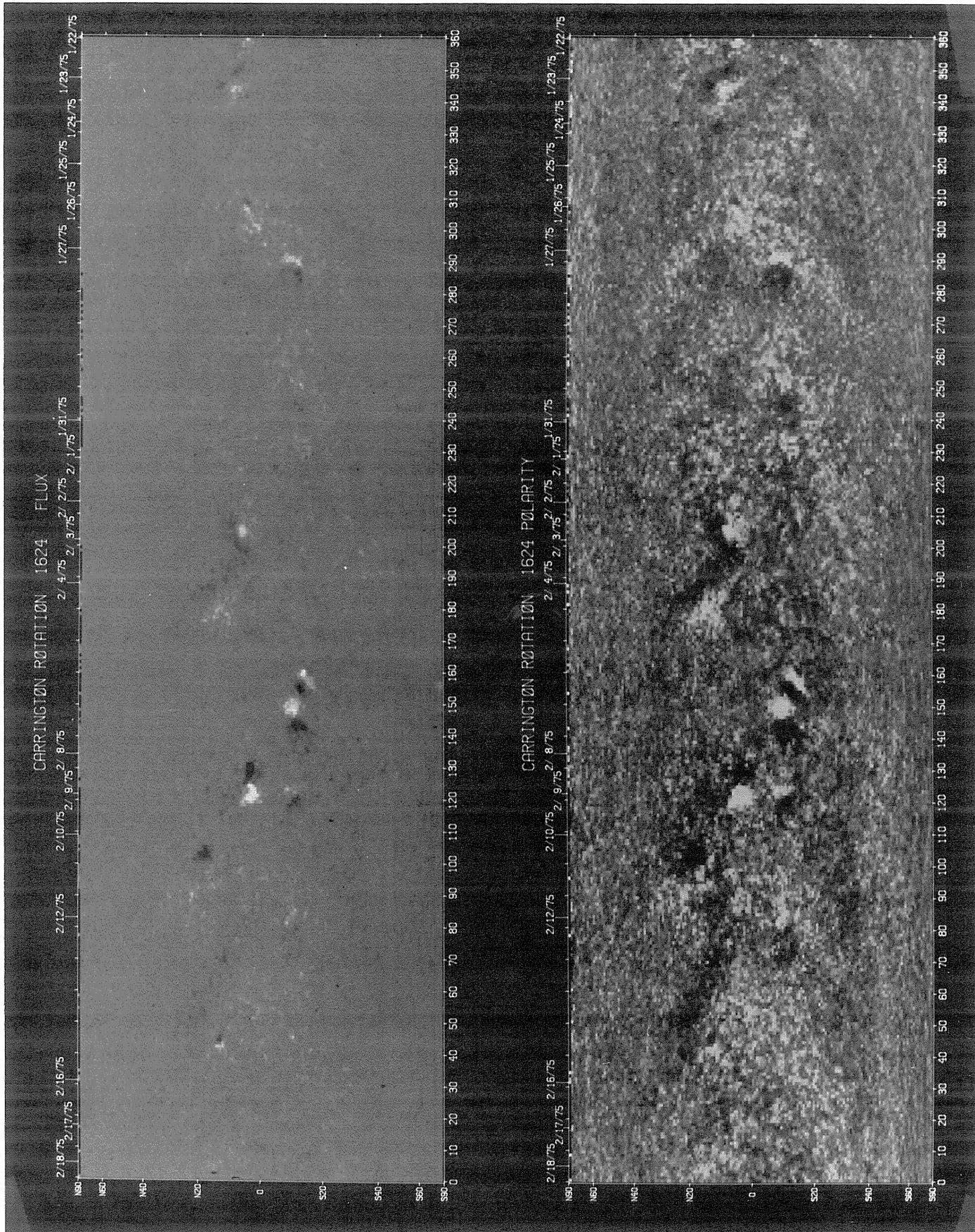
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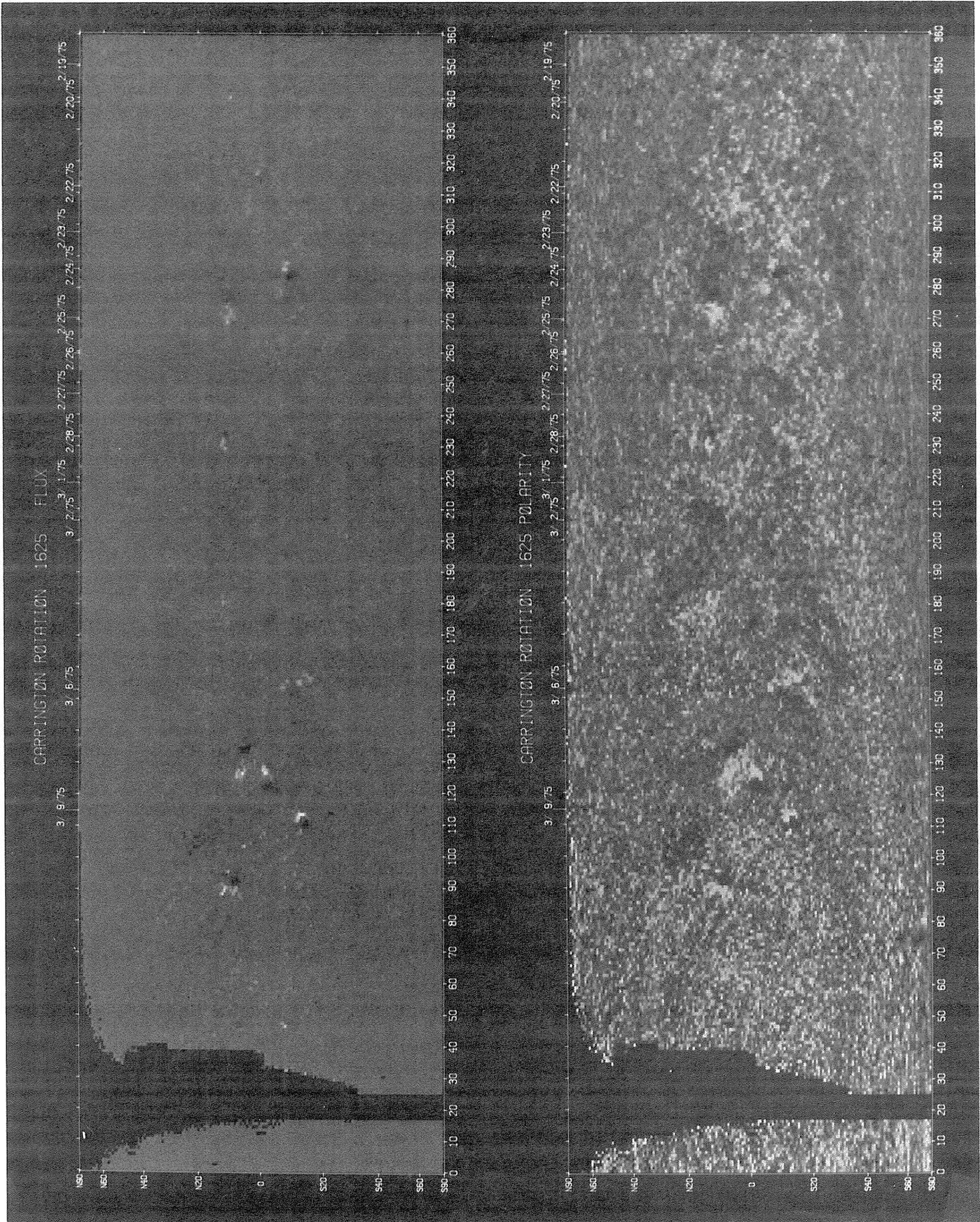


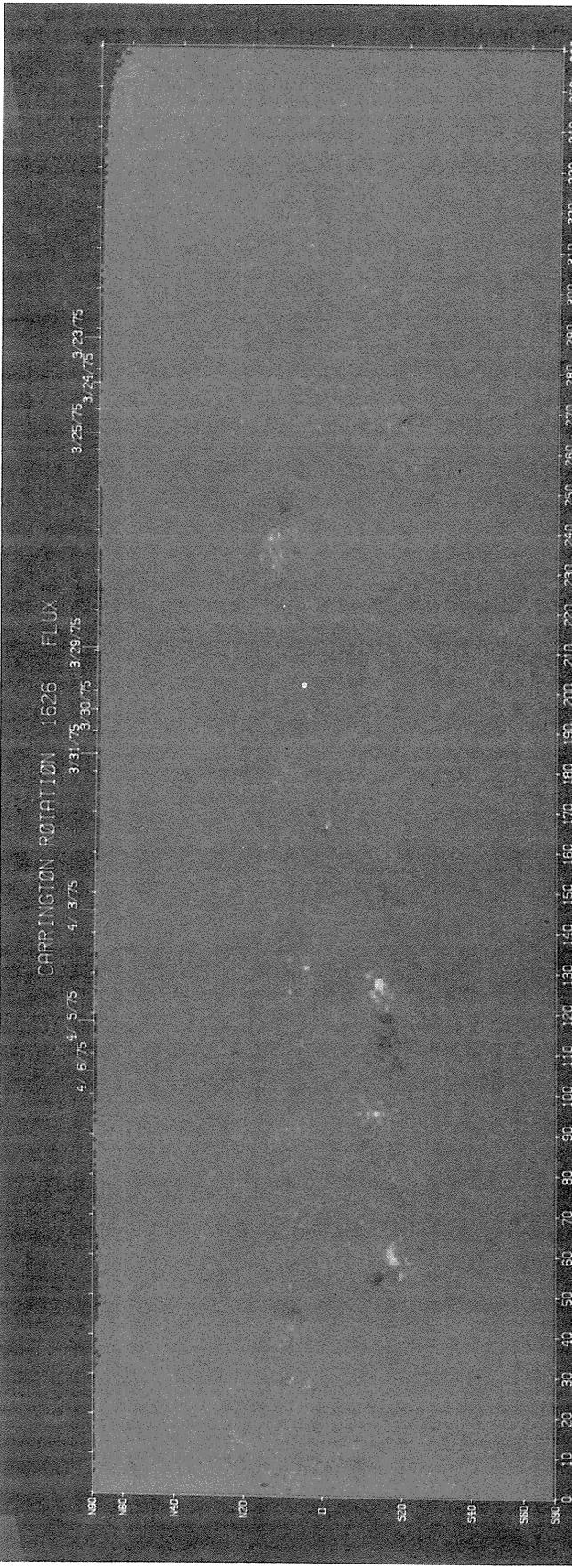


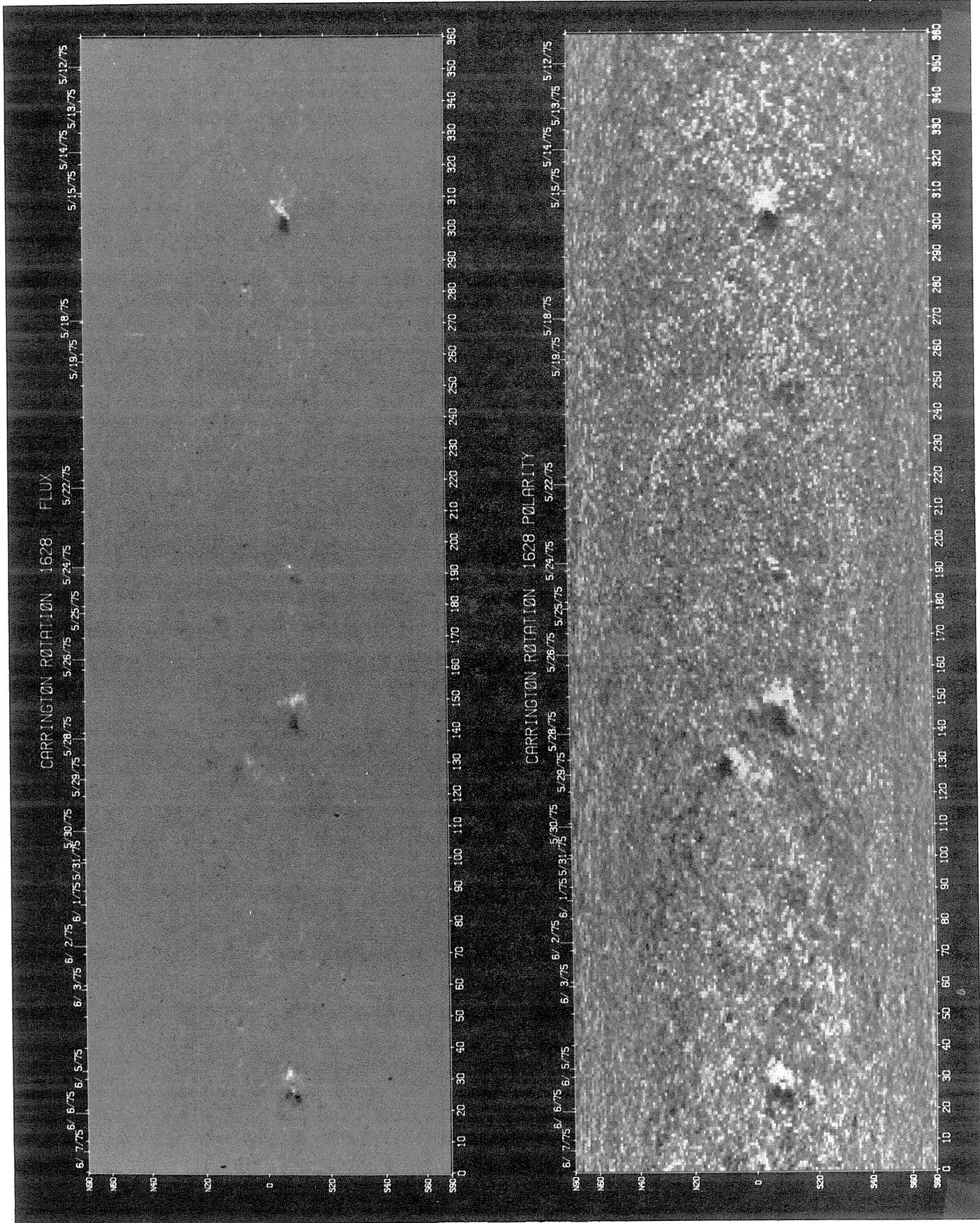




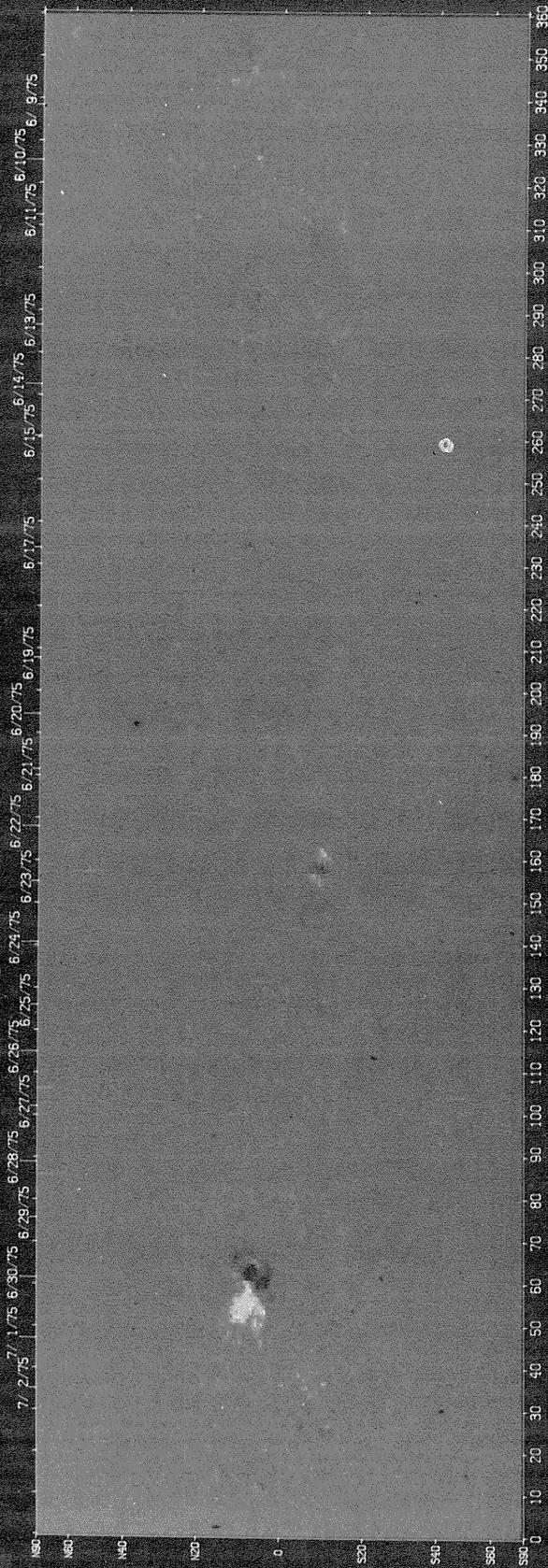






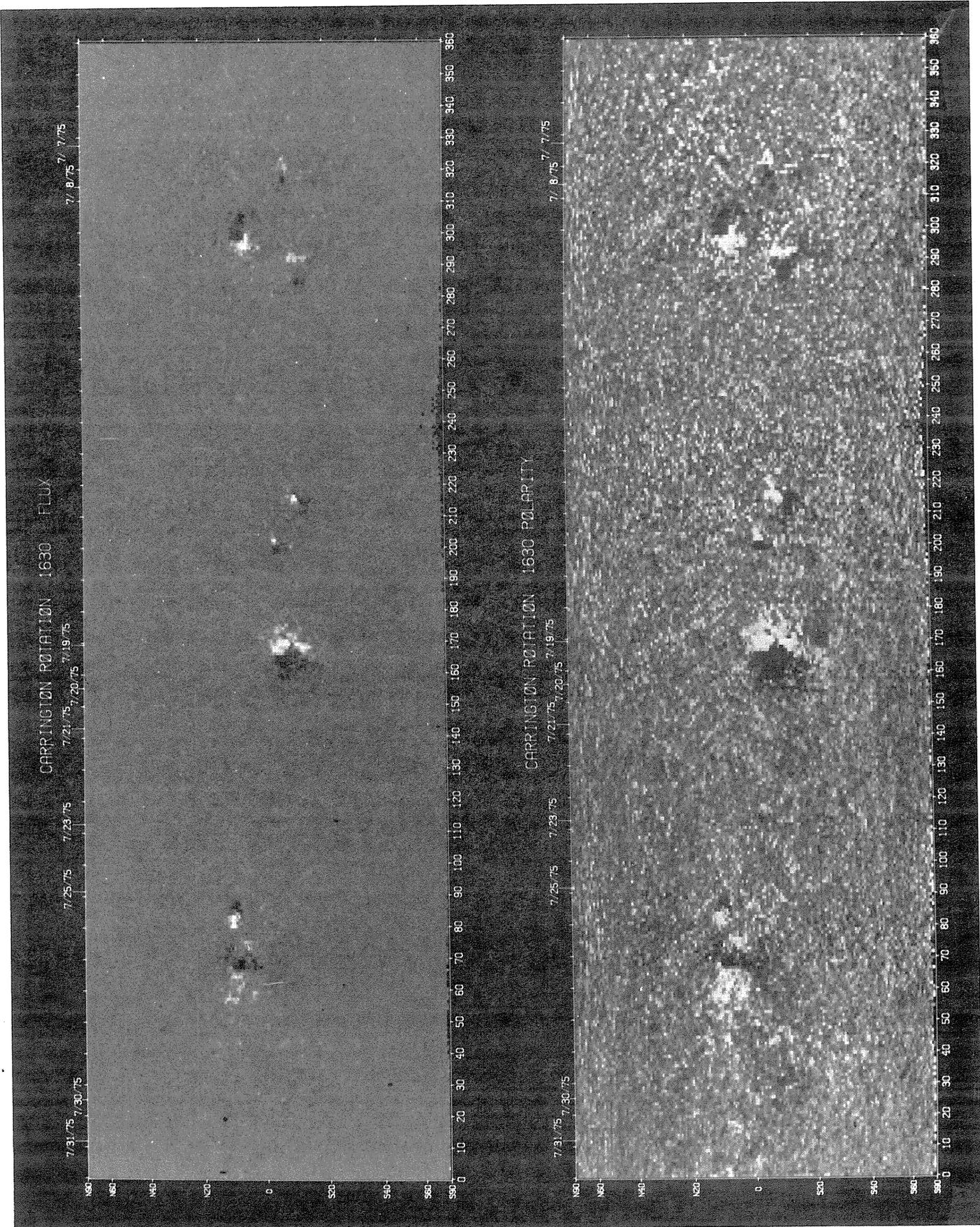


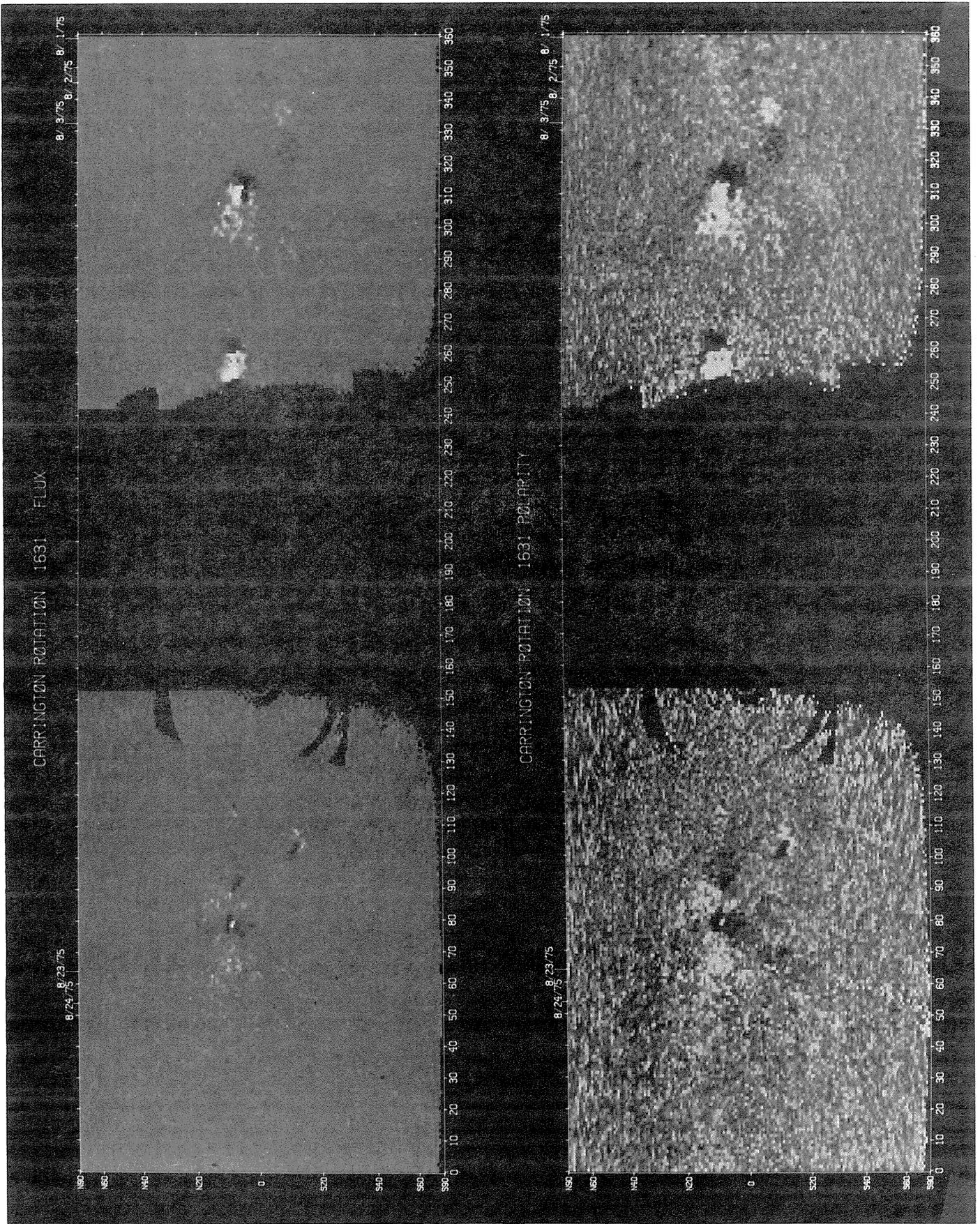
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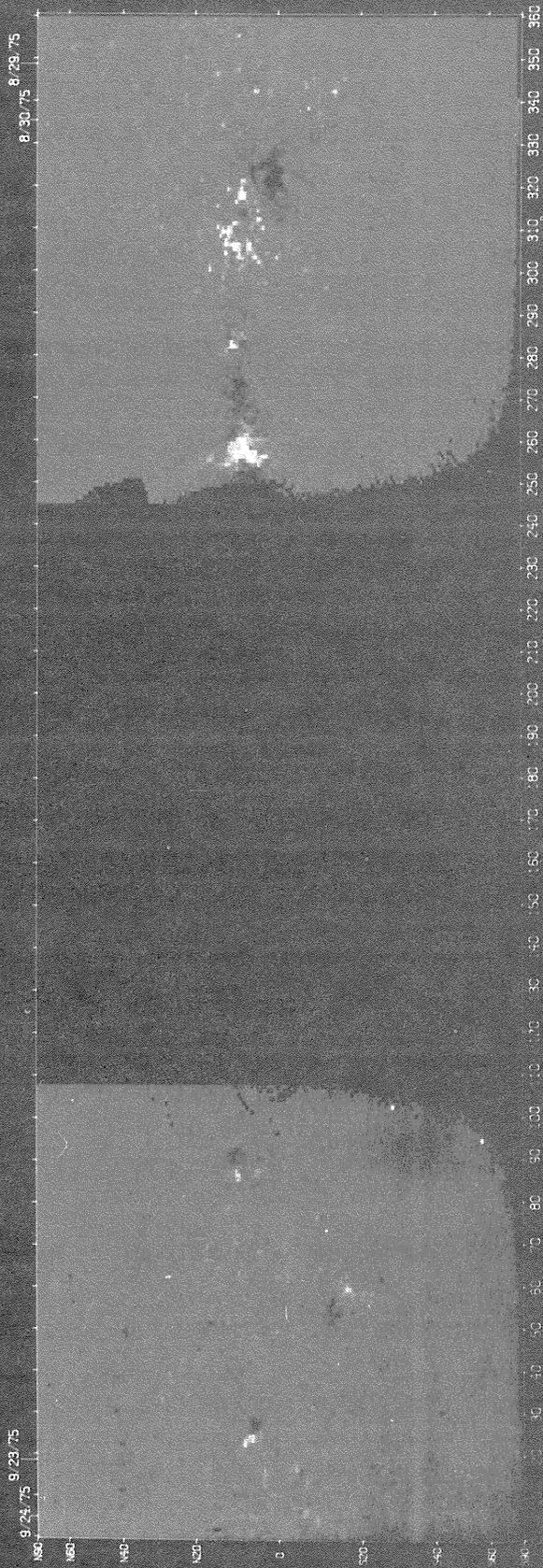
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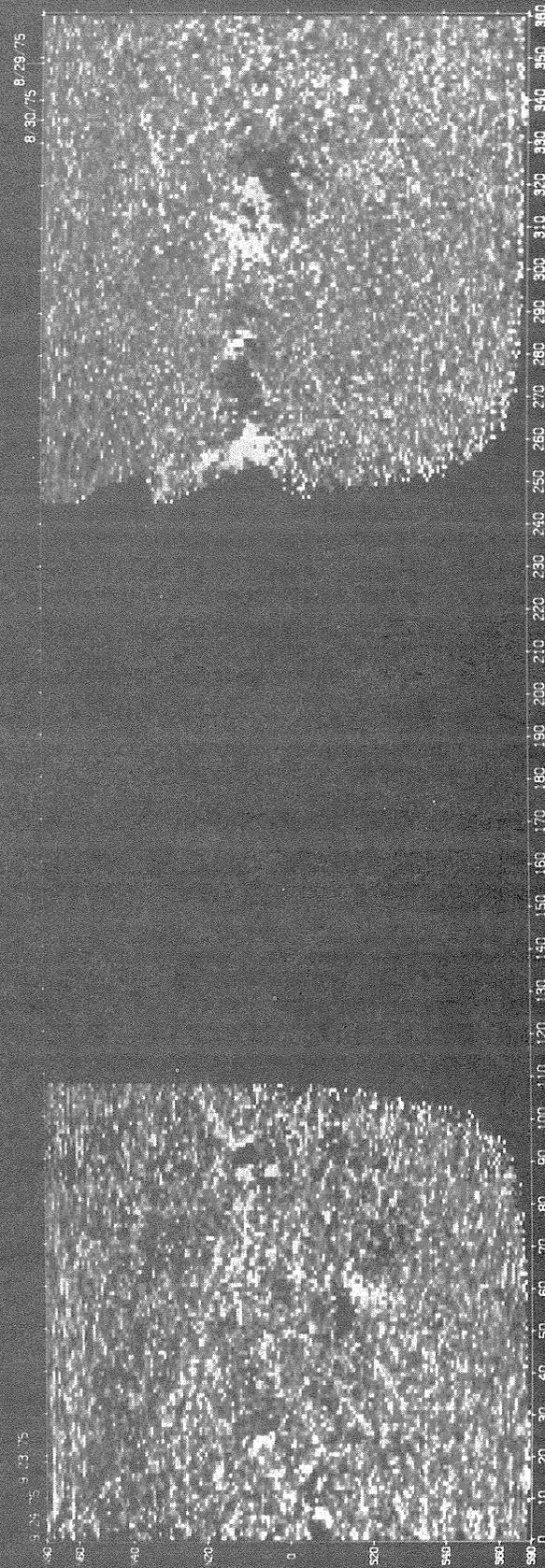


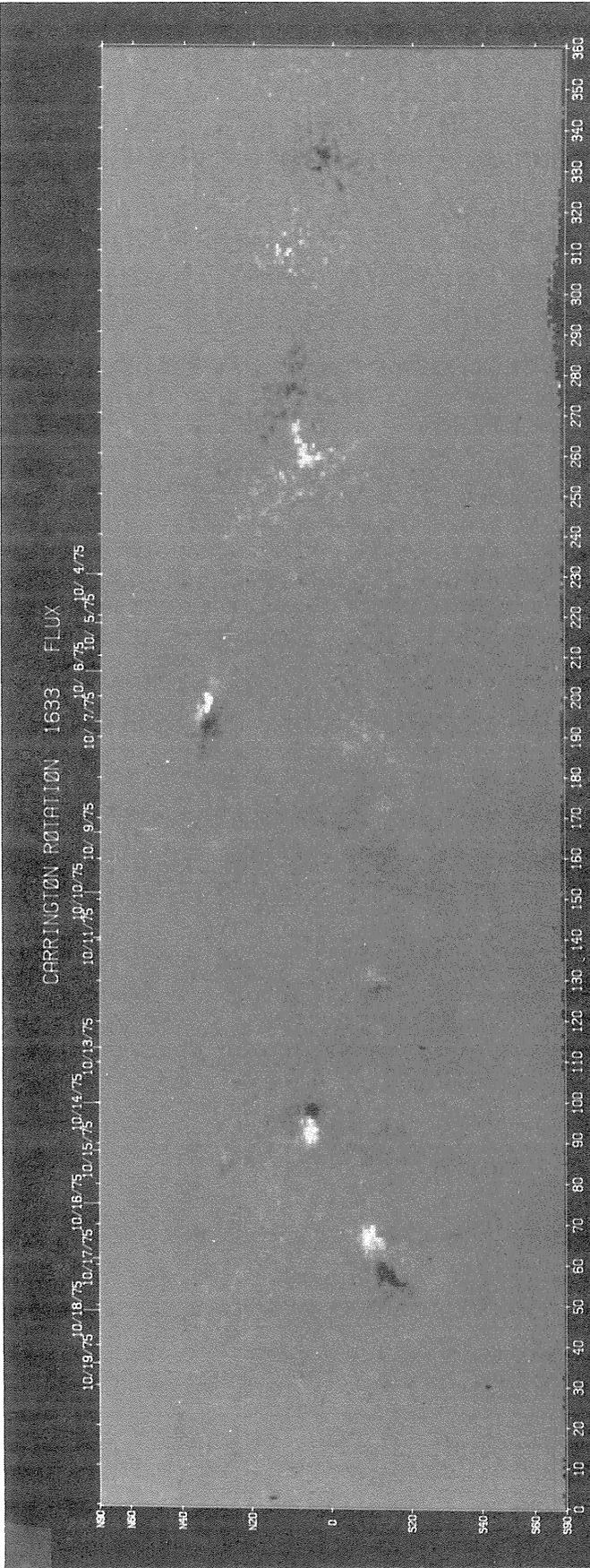


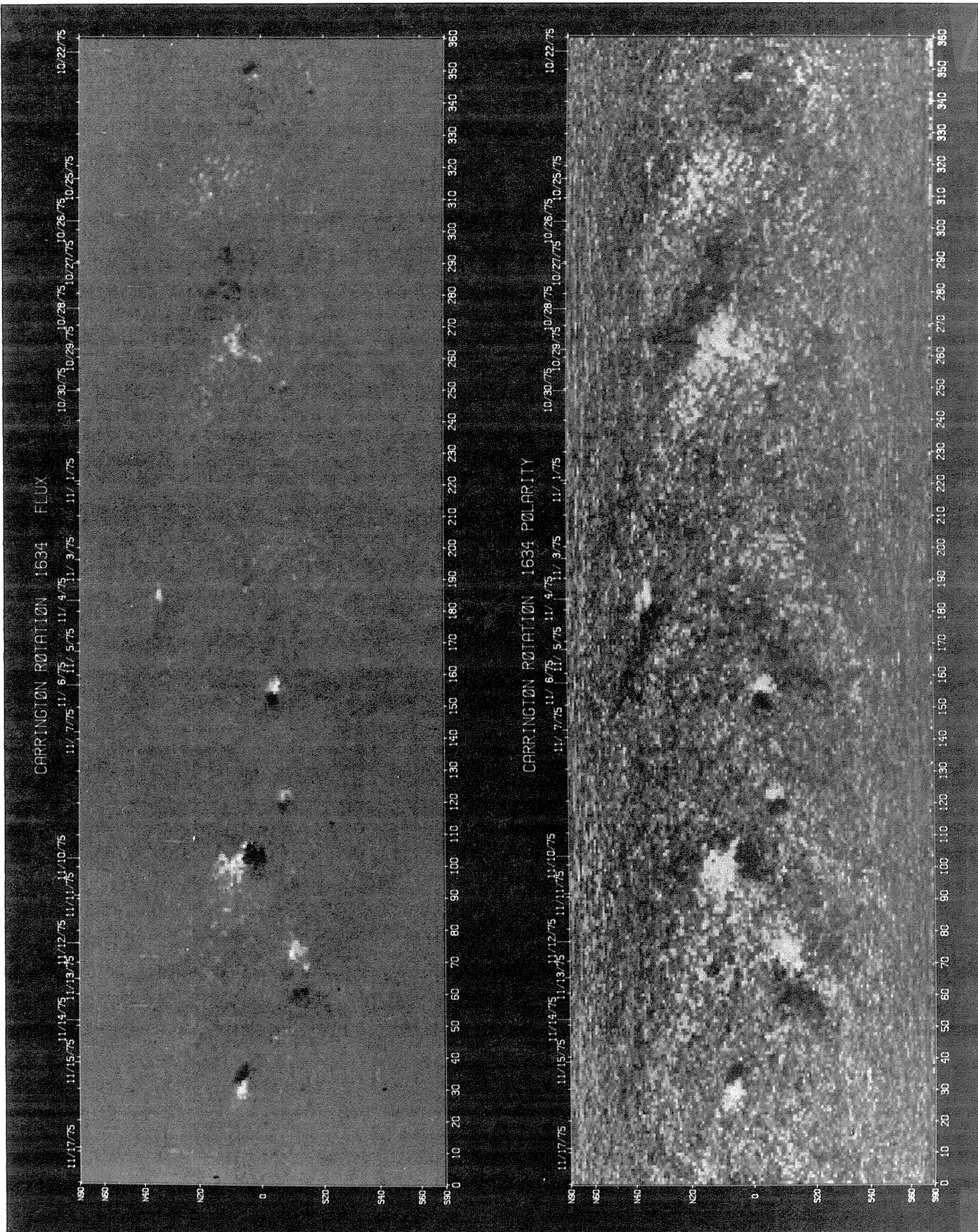
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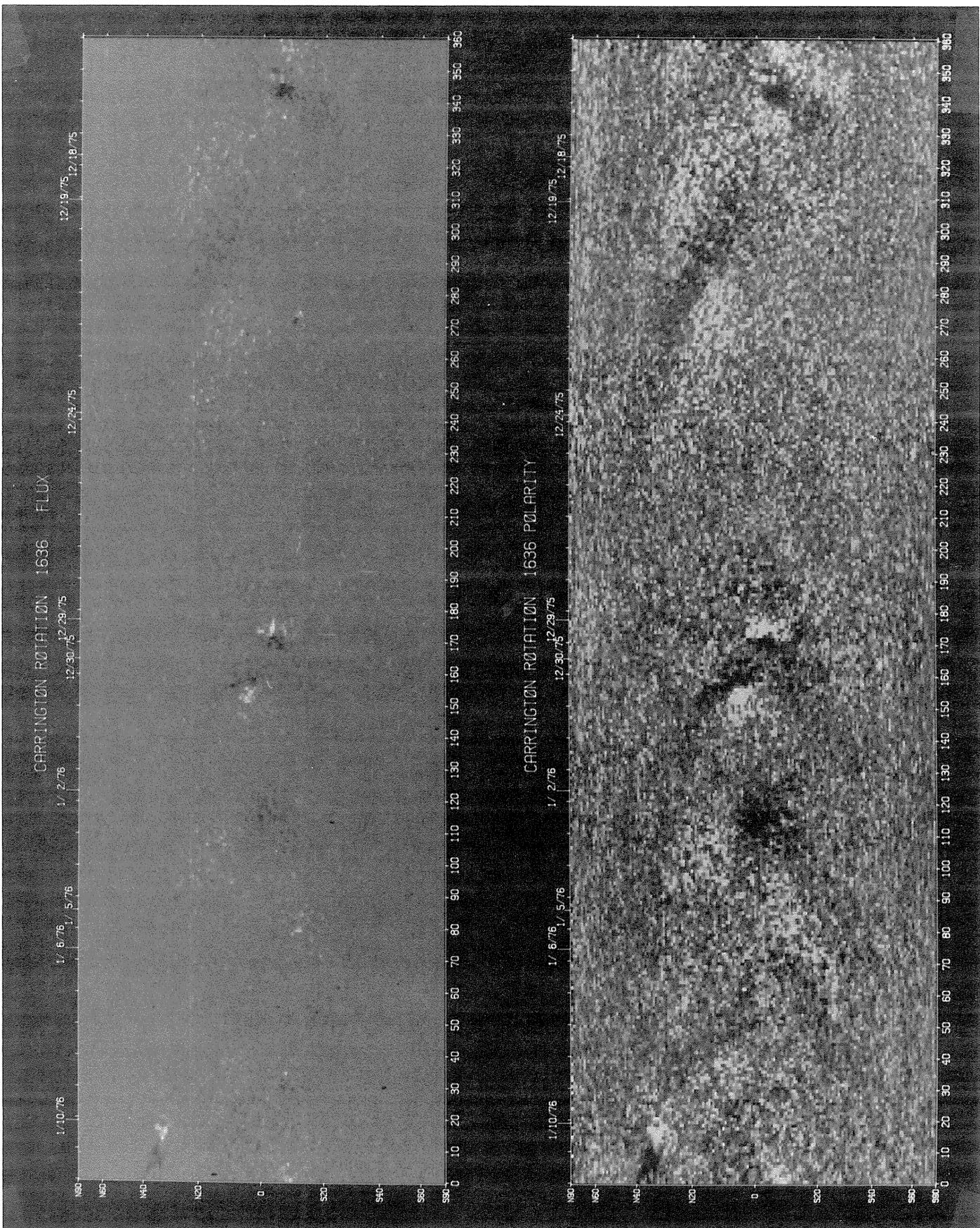


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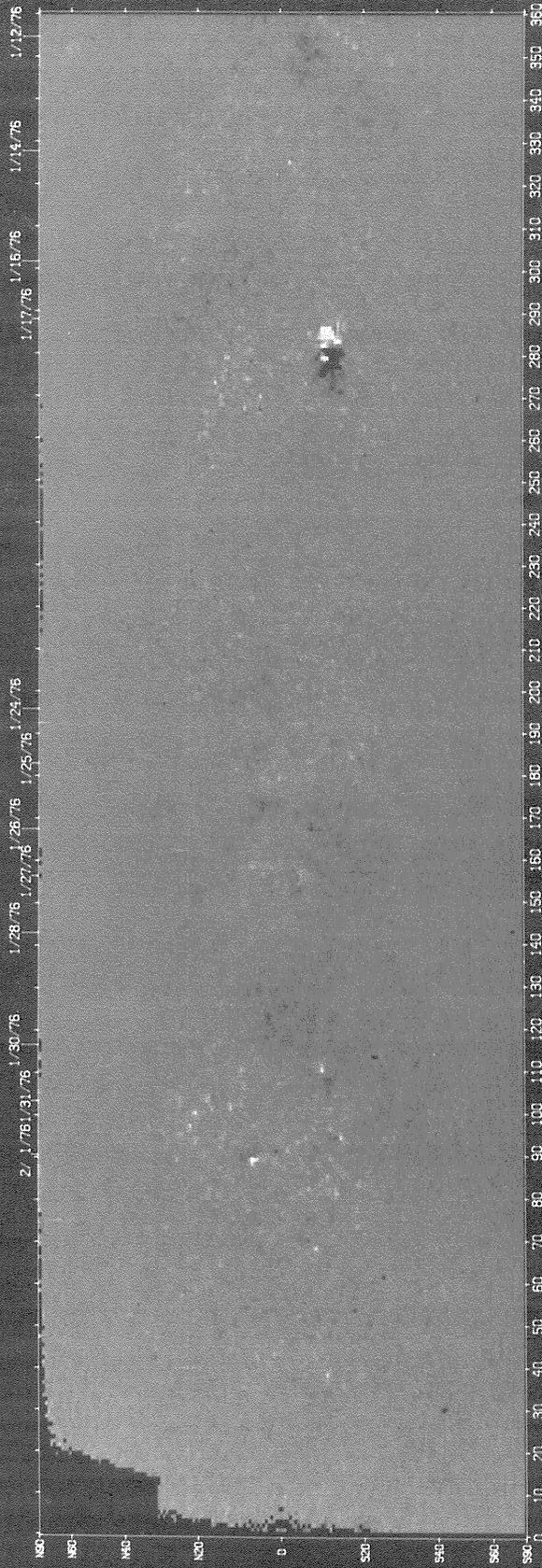




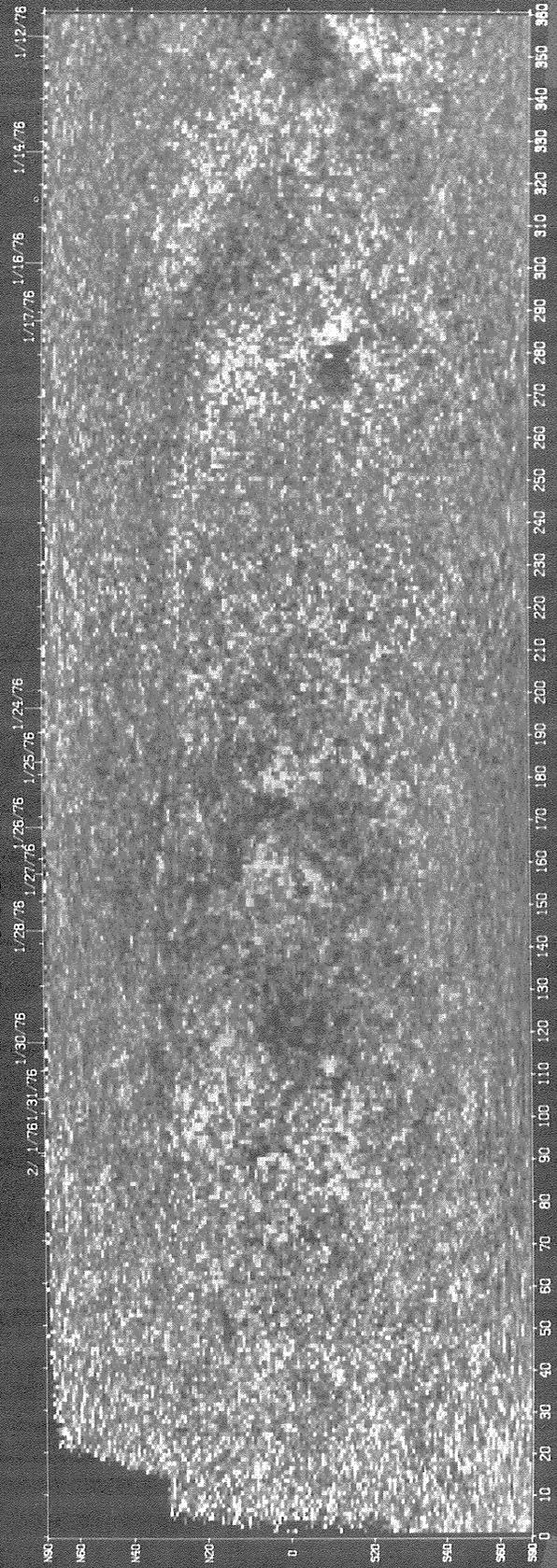




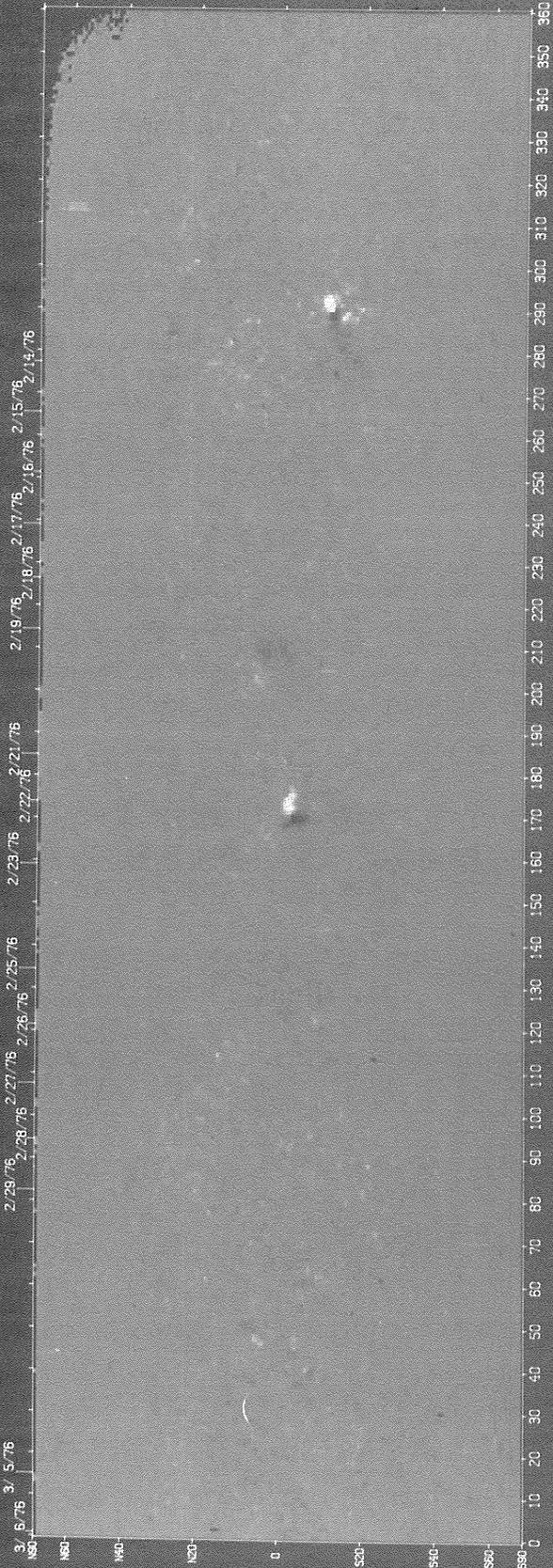
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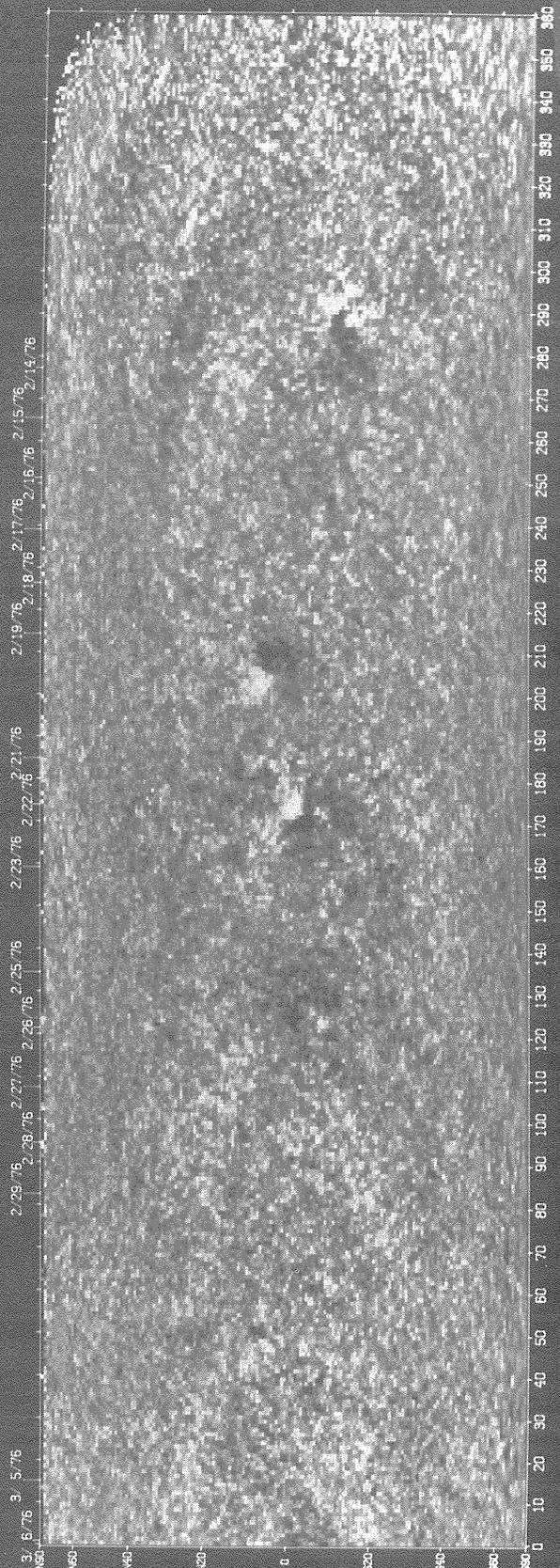
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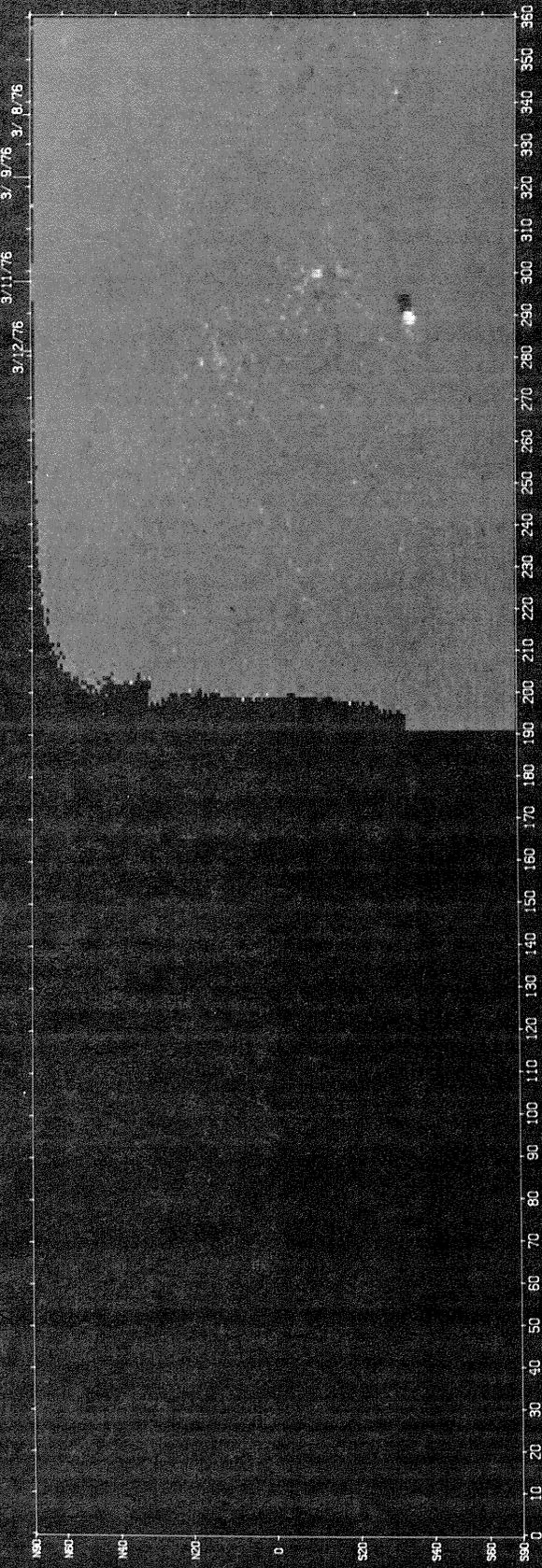
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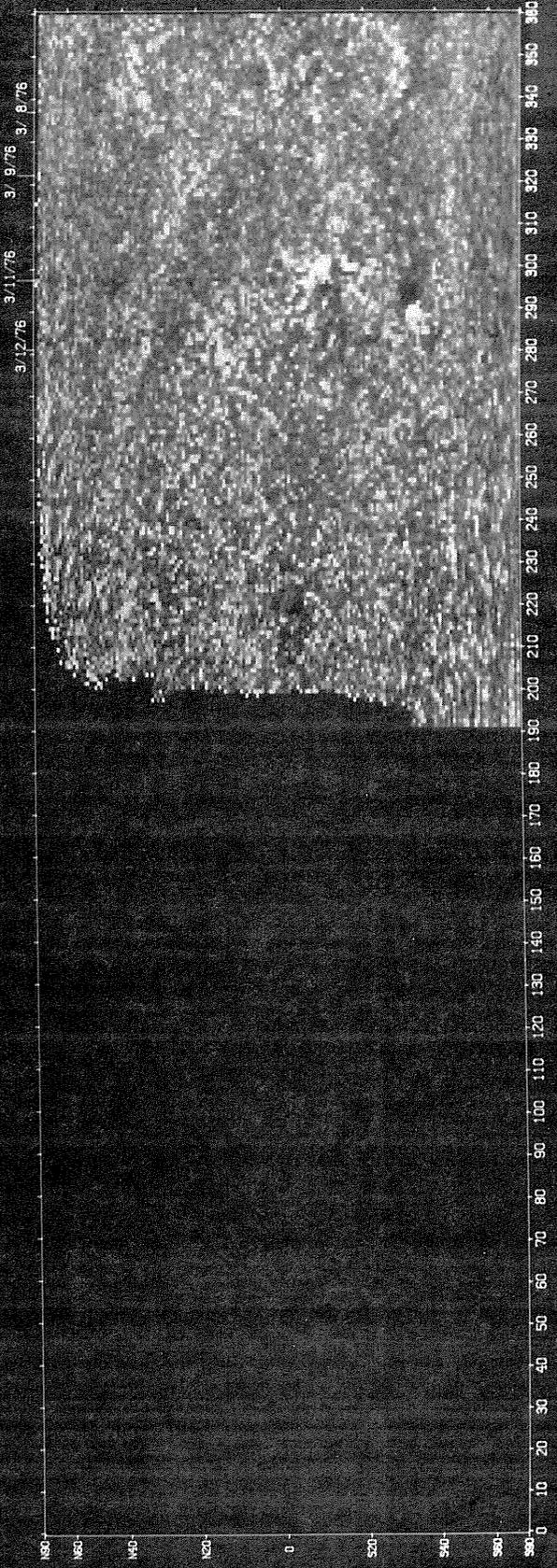
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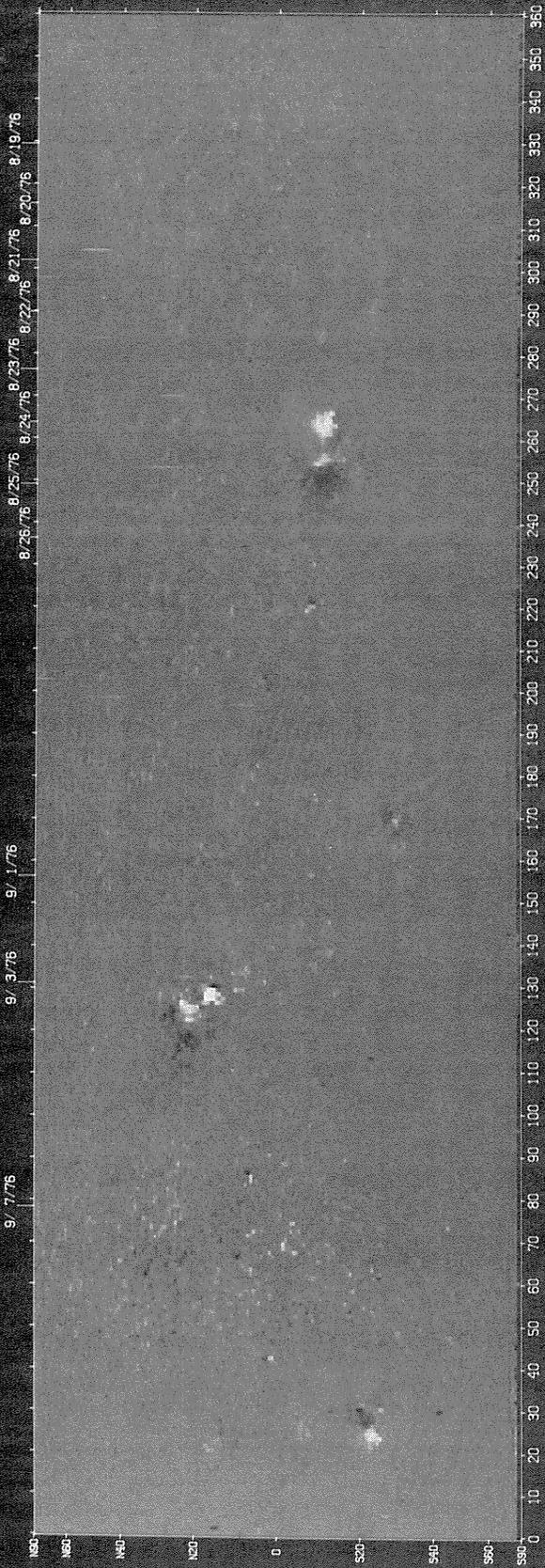
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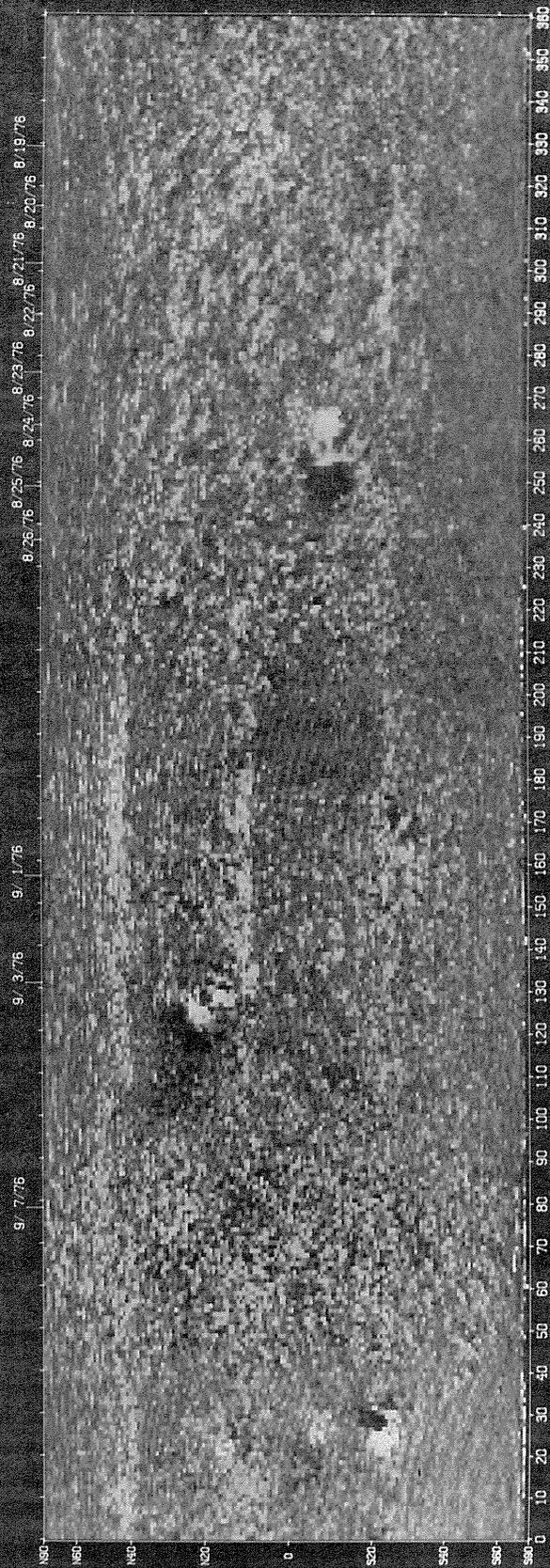
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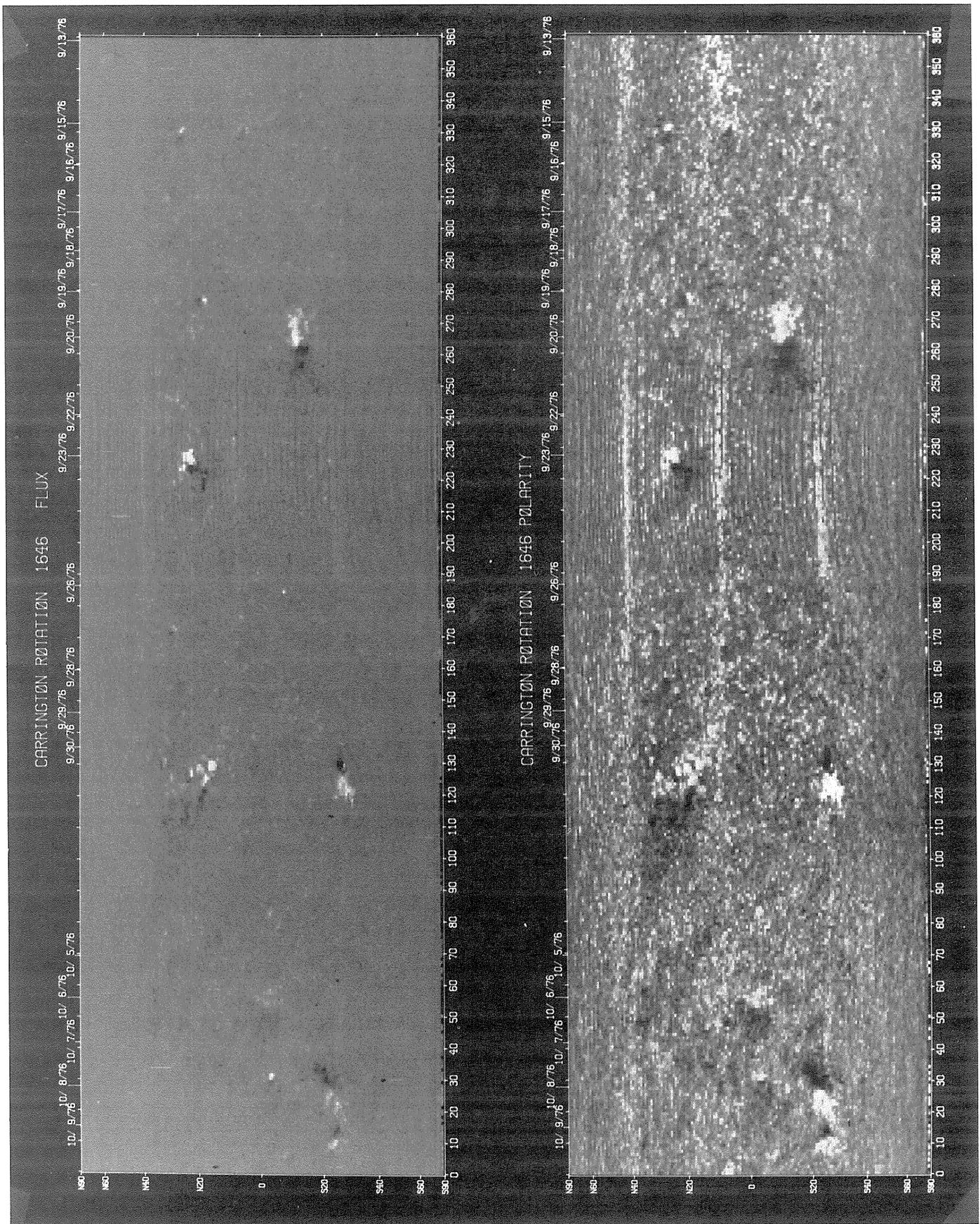


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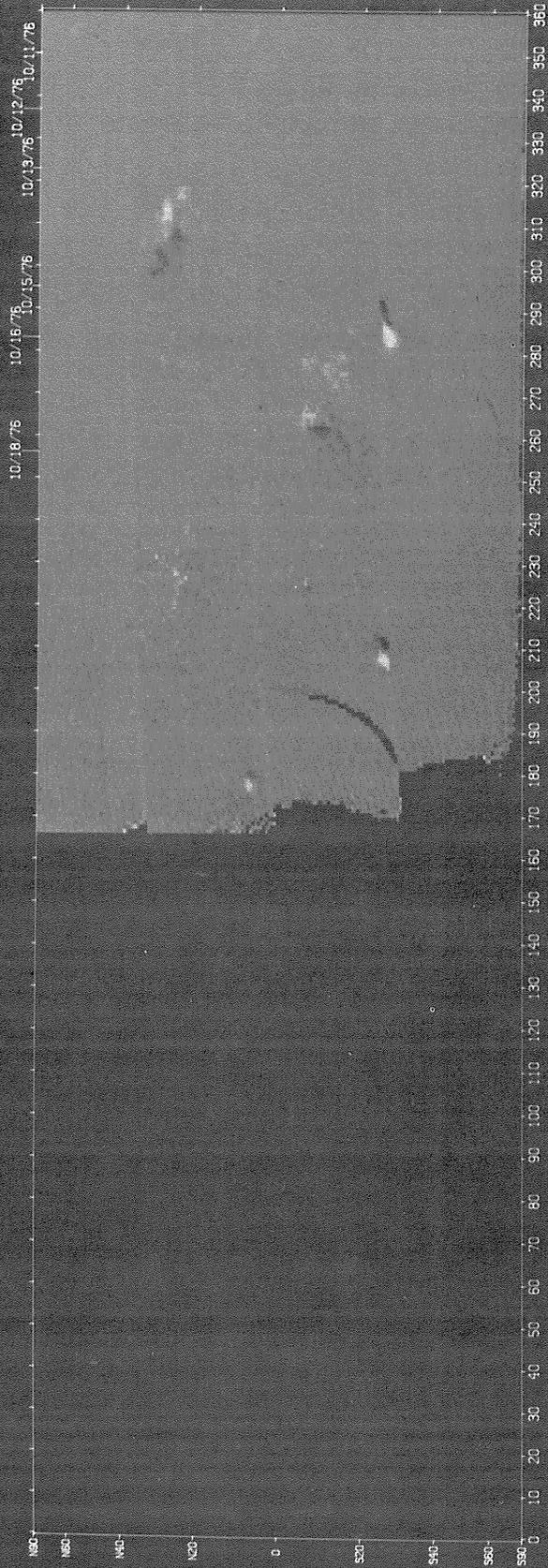


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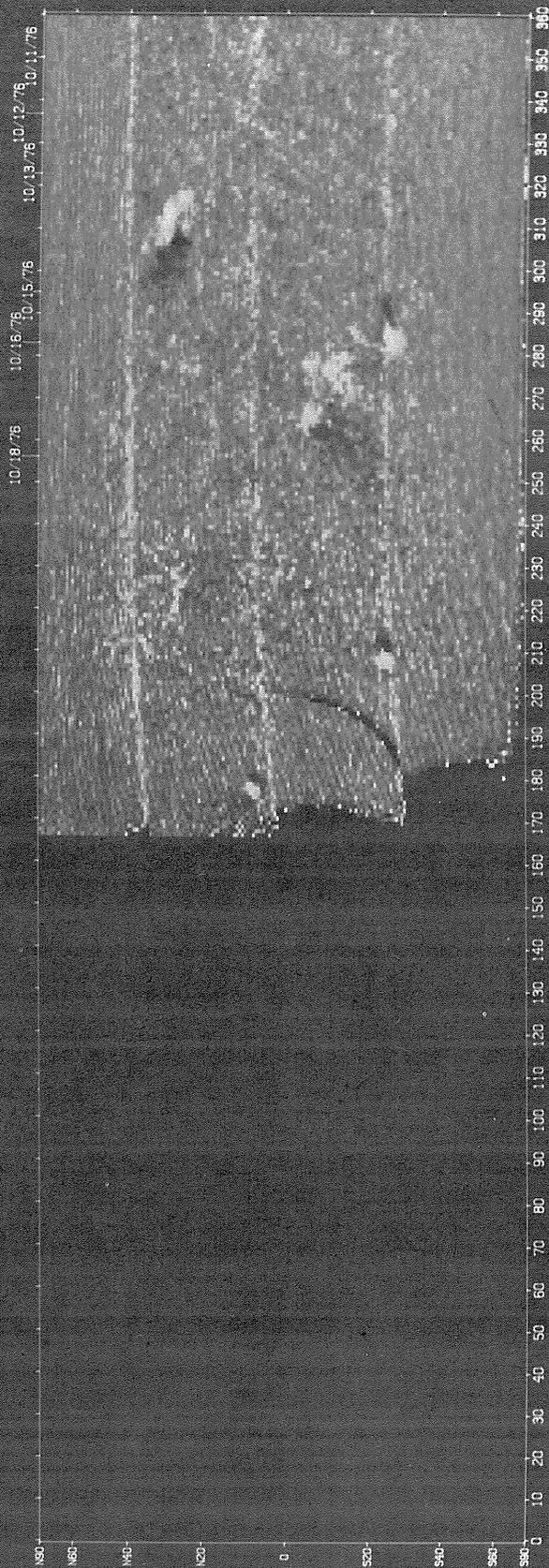




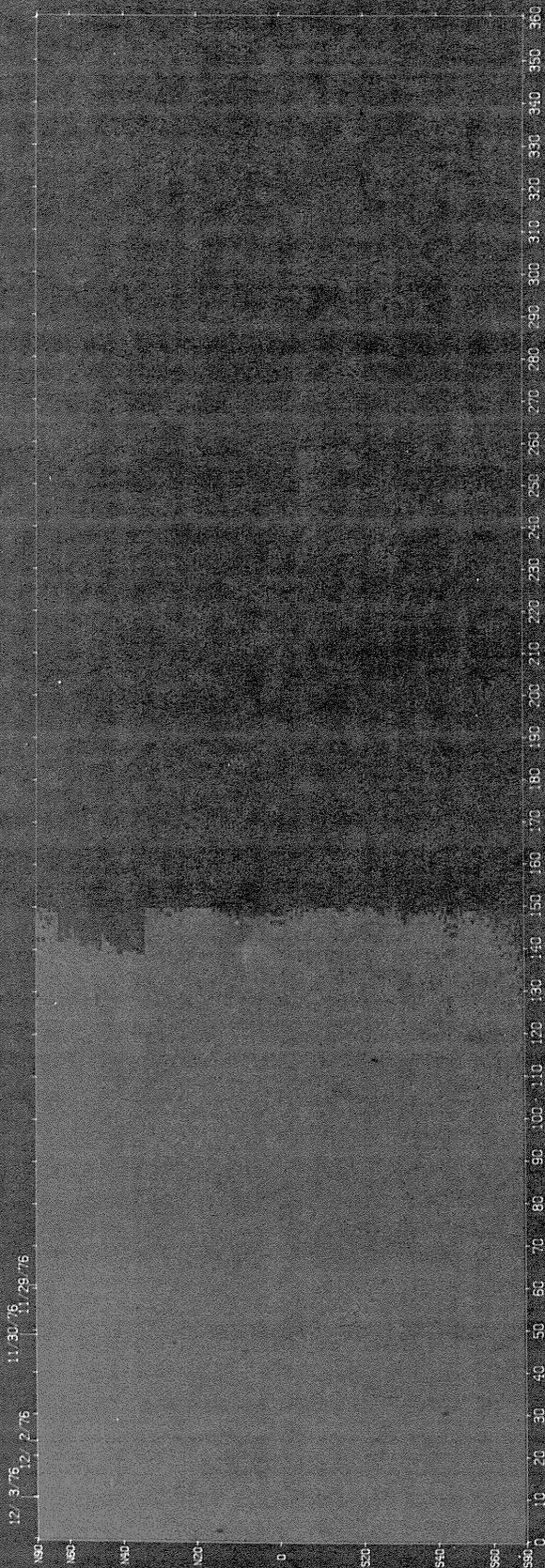
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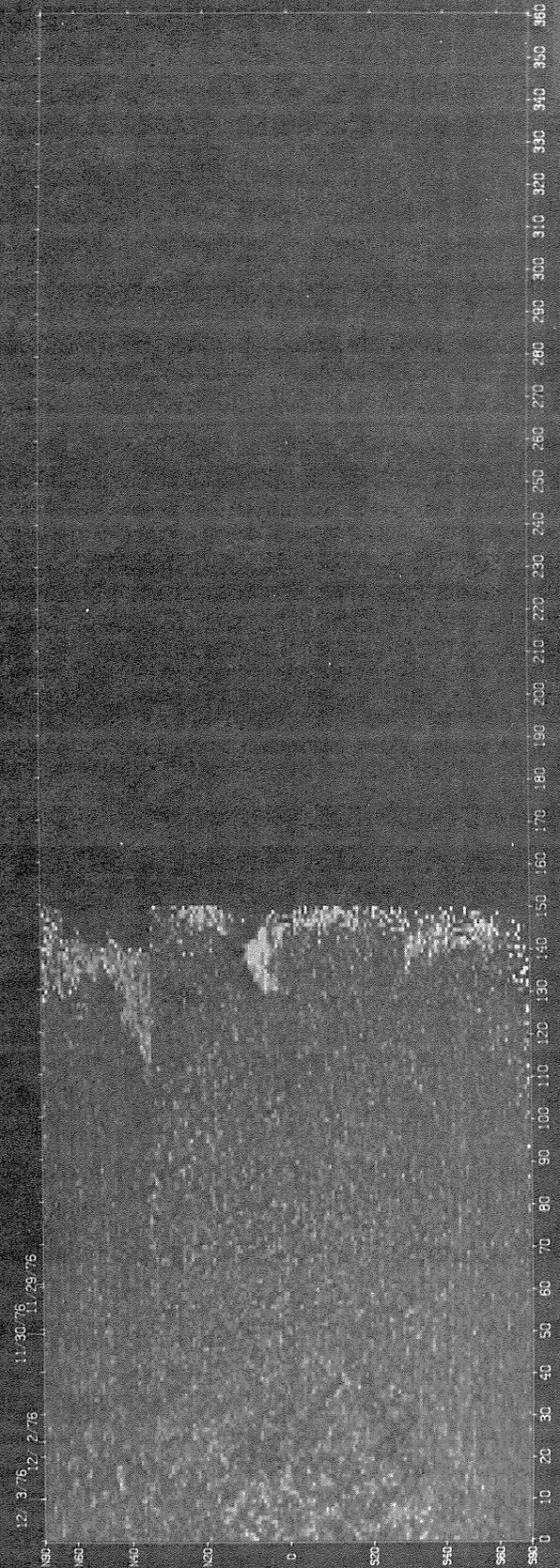
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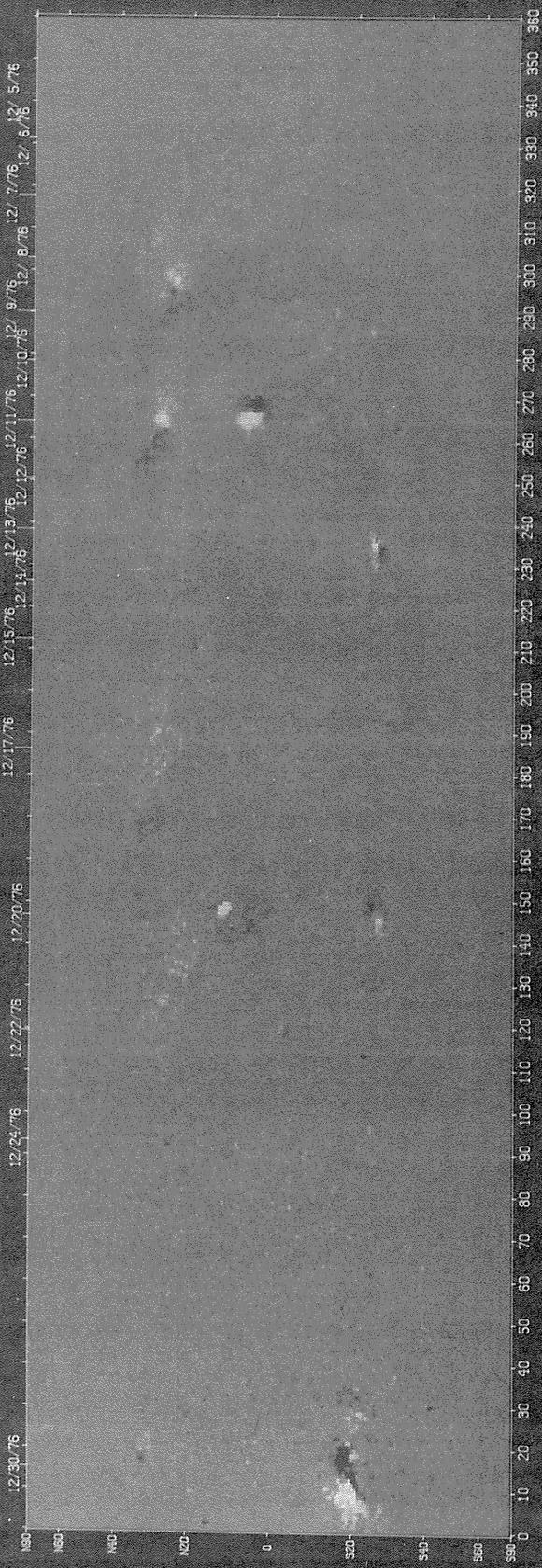
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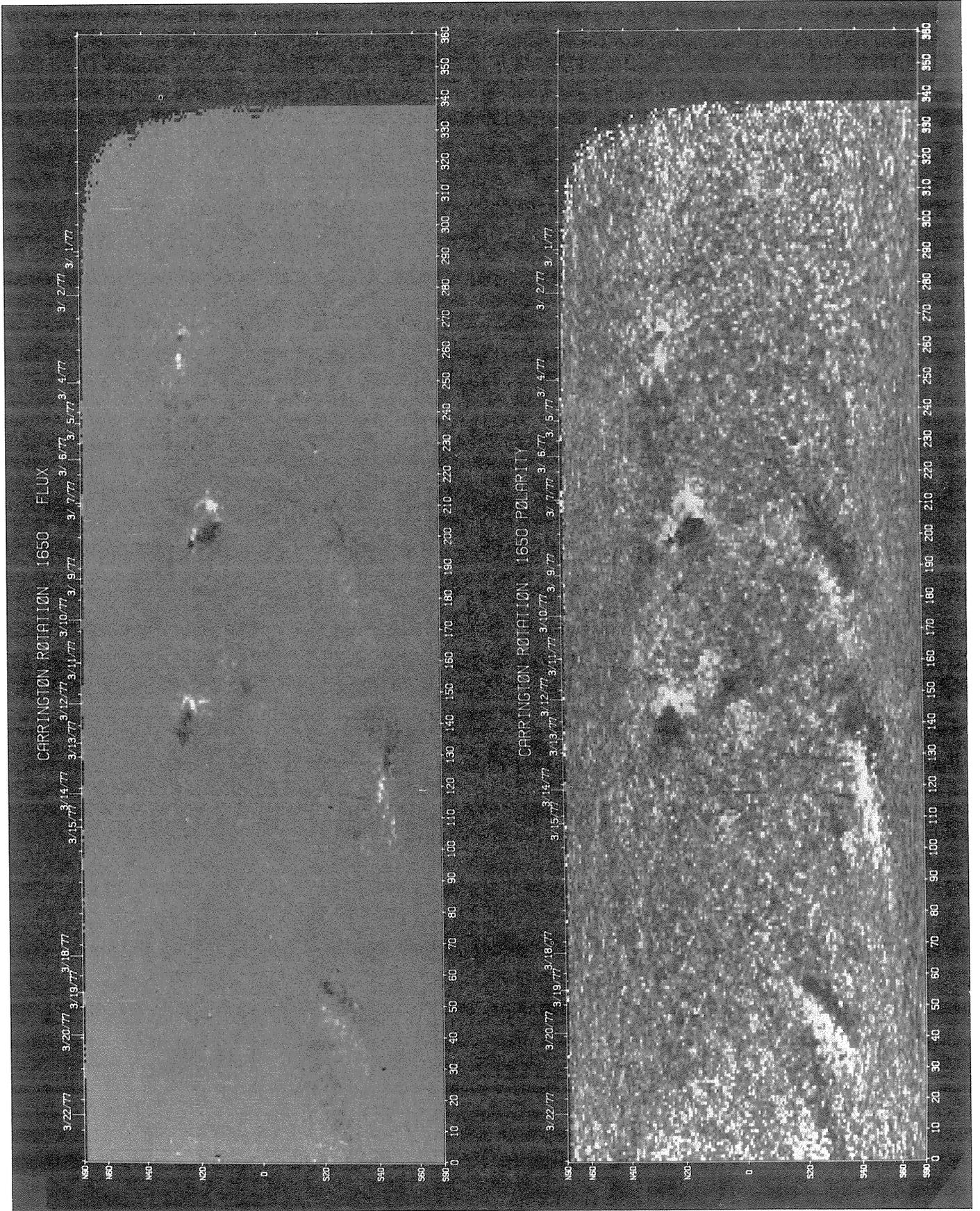


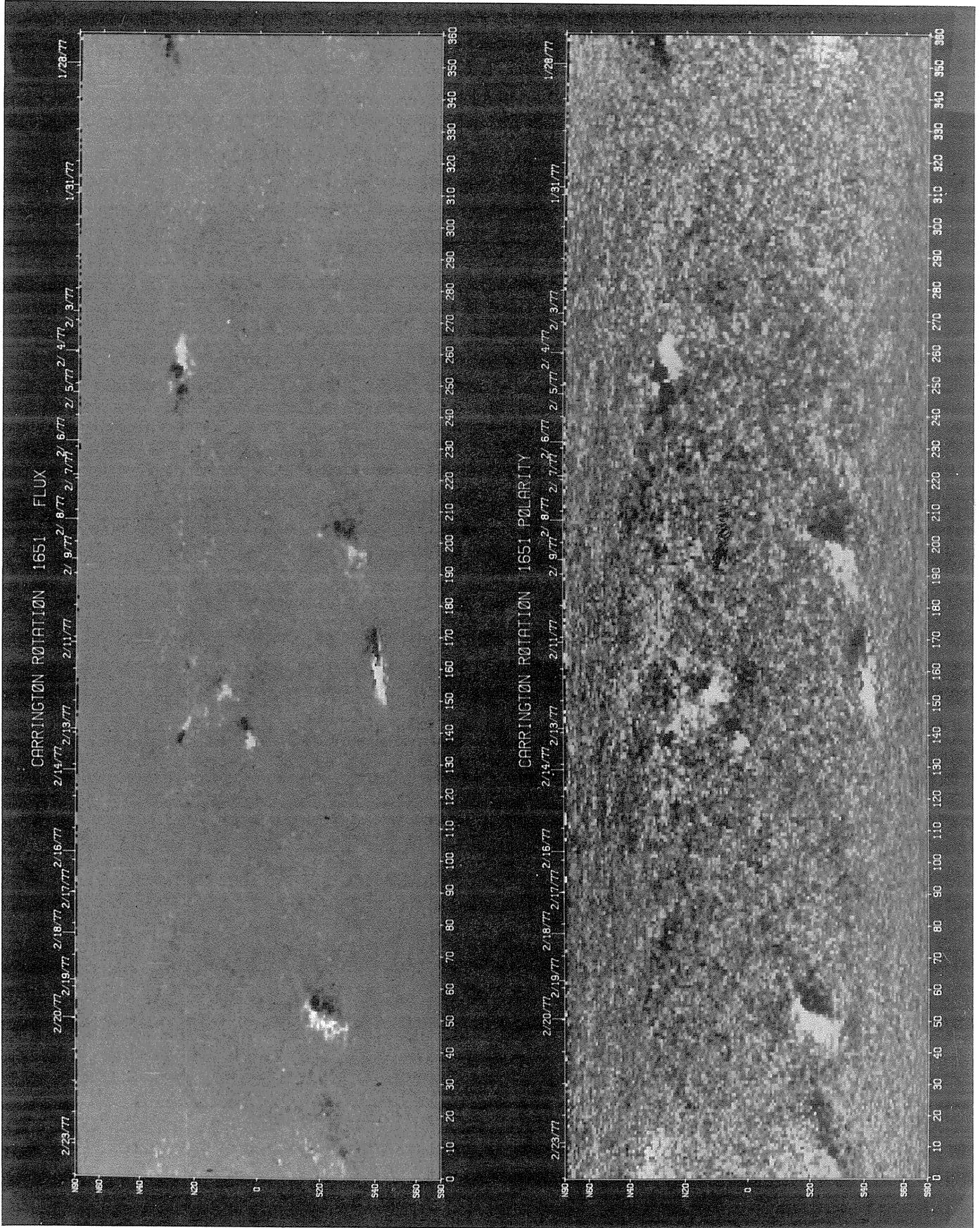
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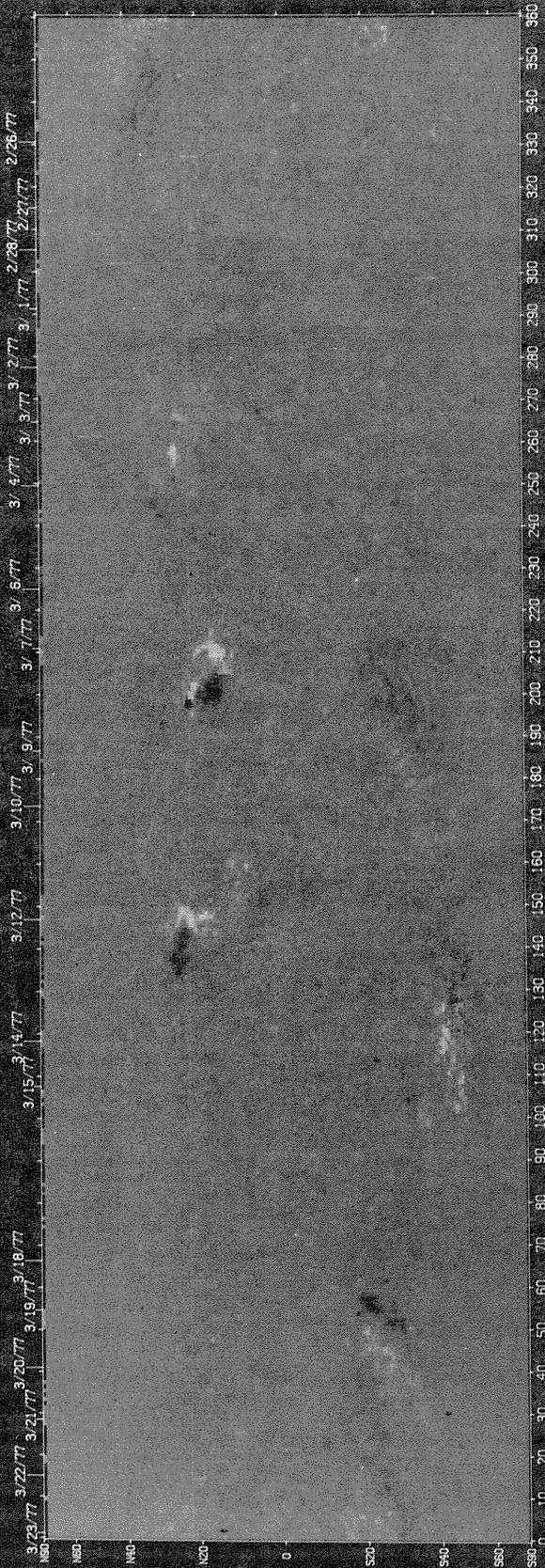
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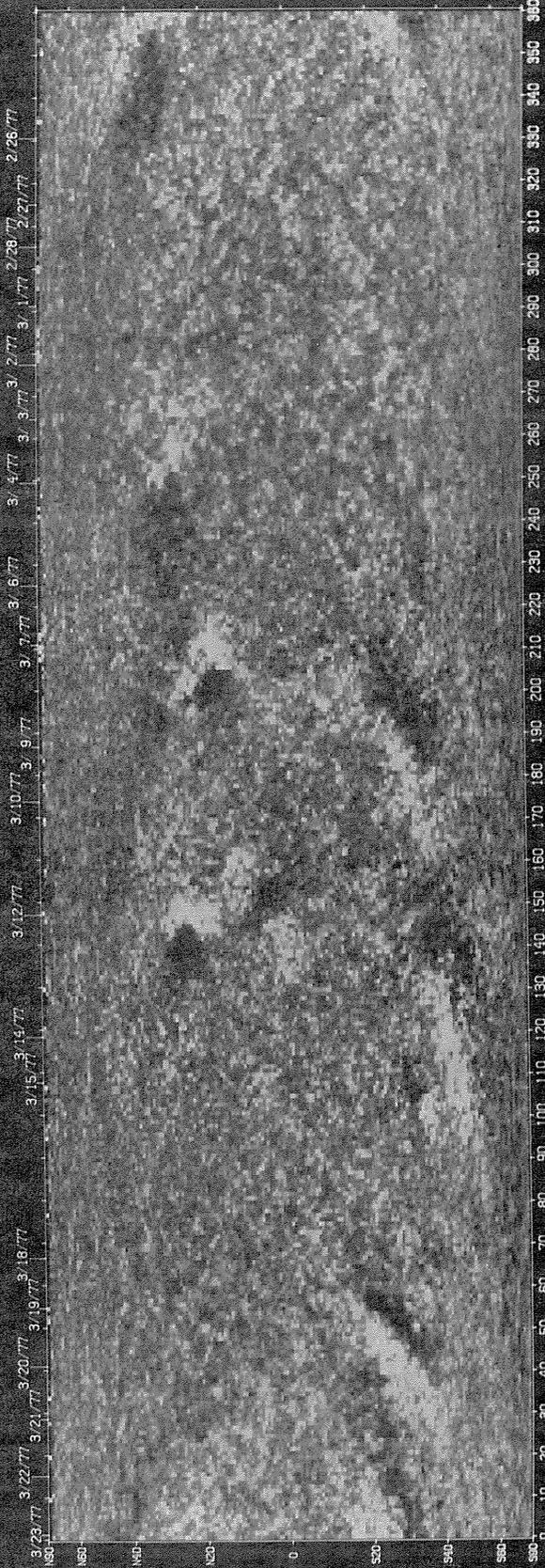


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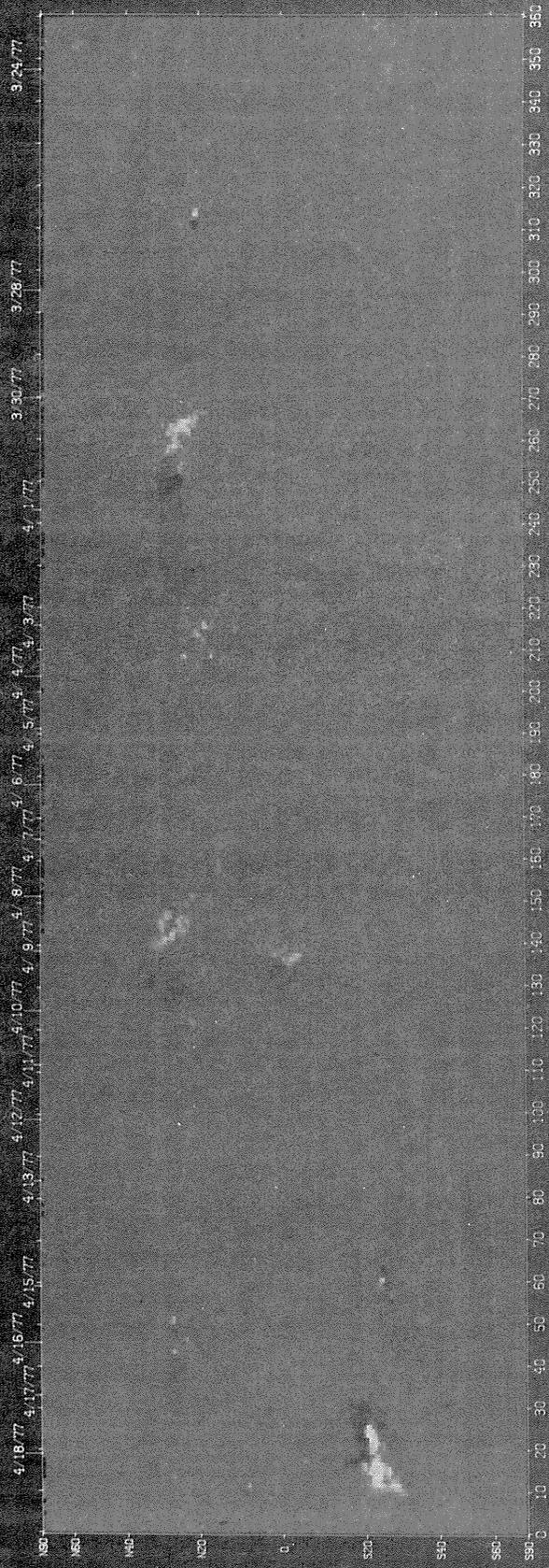
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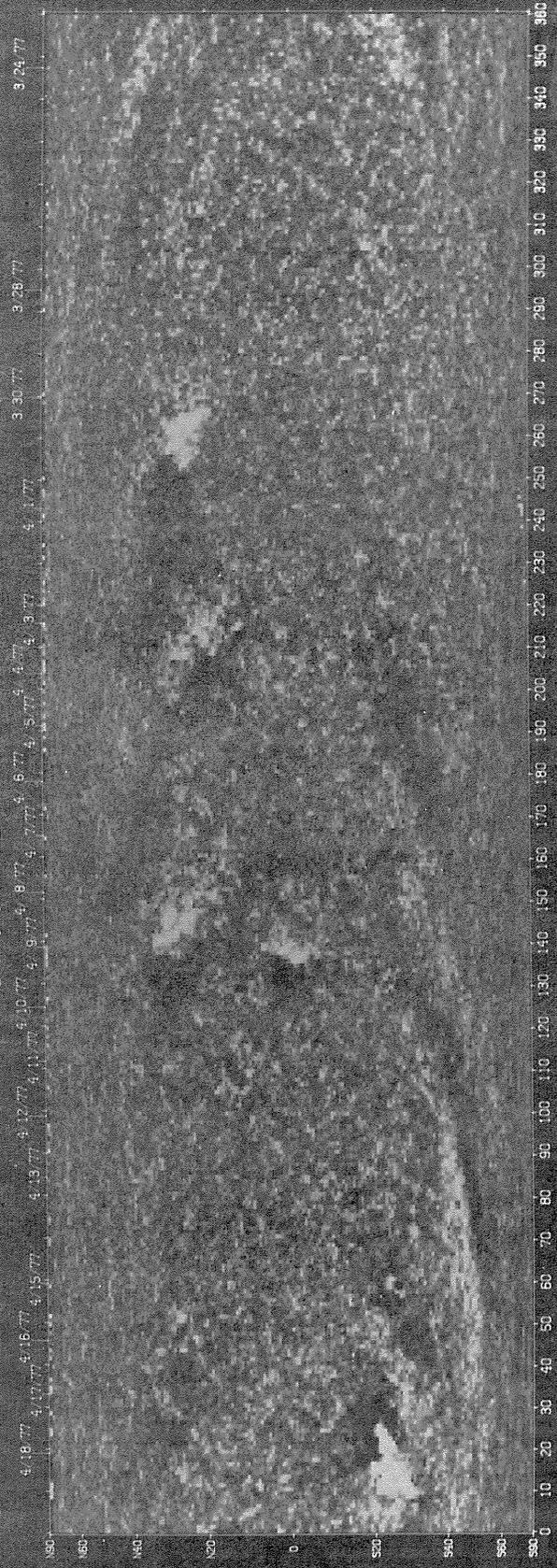


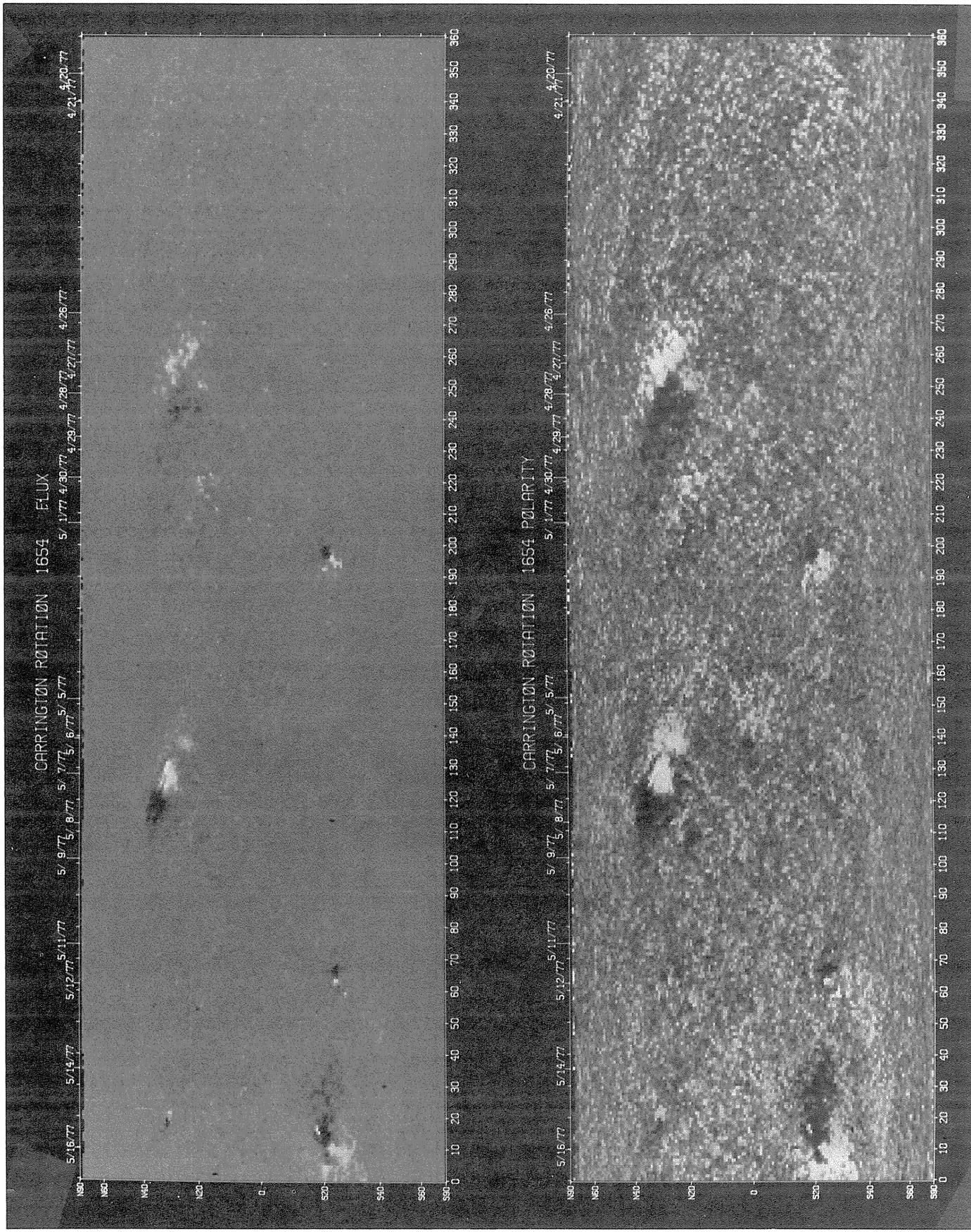
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CARRINGTON ROTATION 1653 FLUX

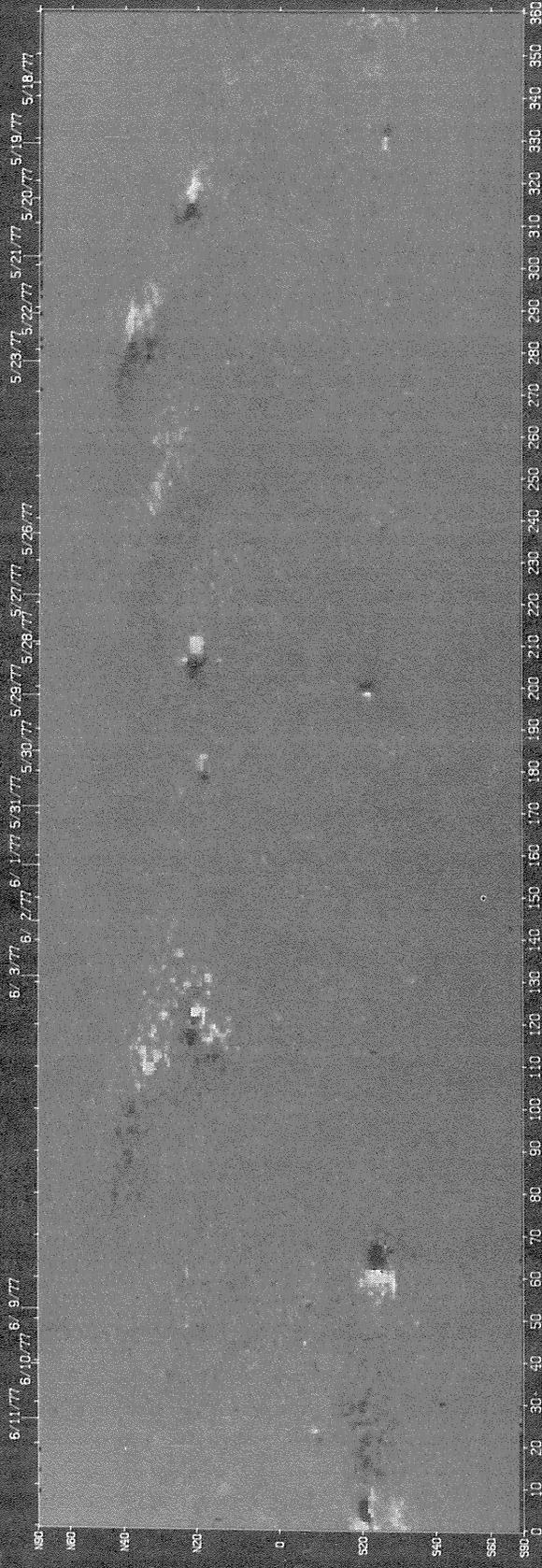


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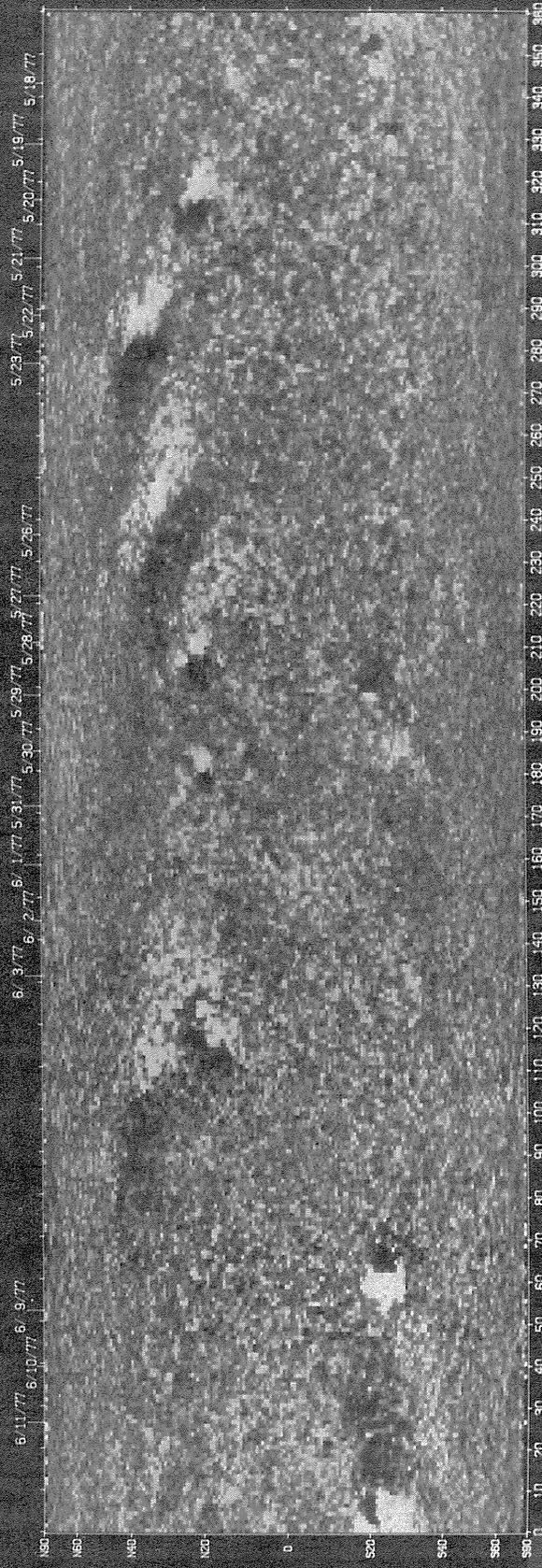


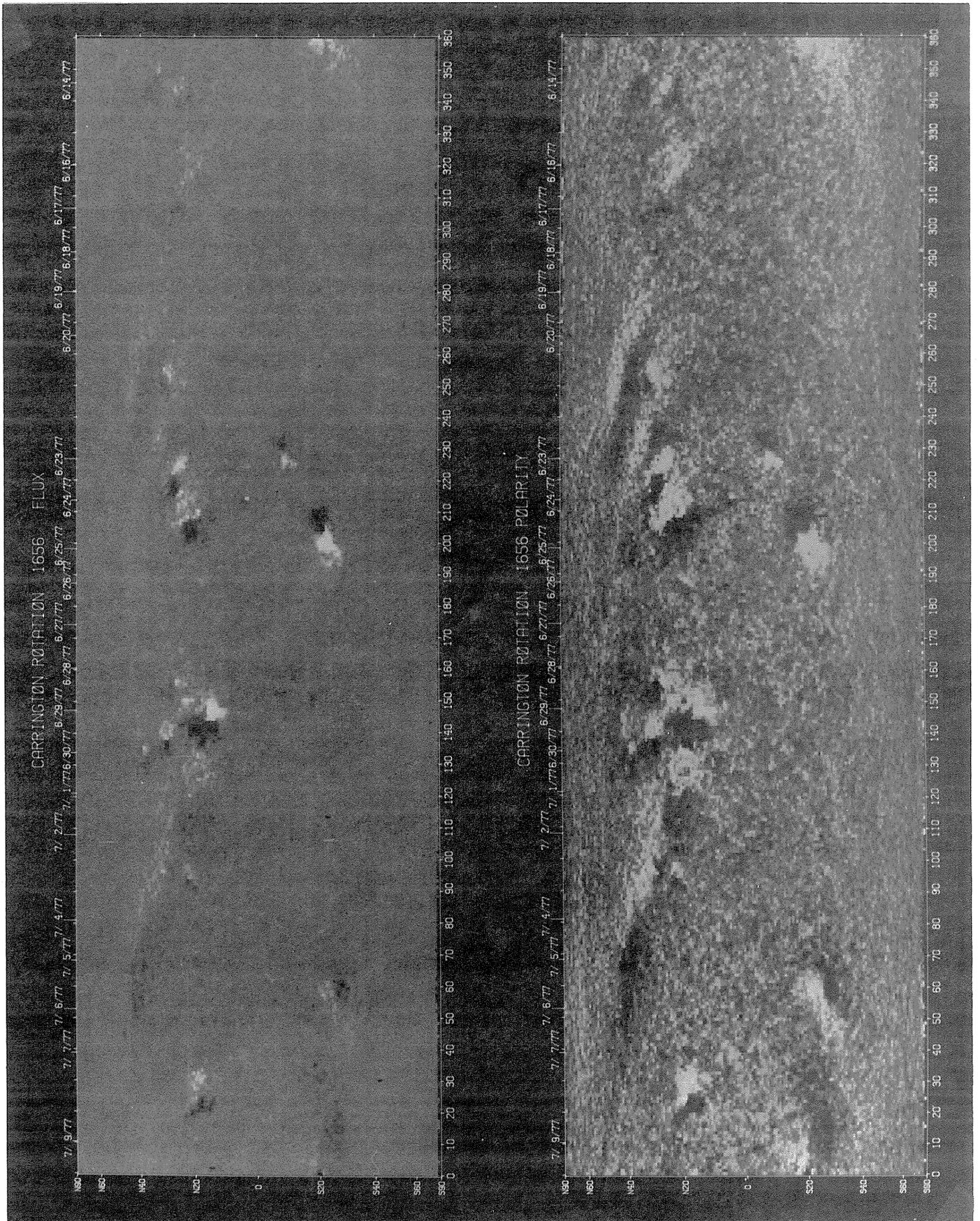


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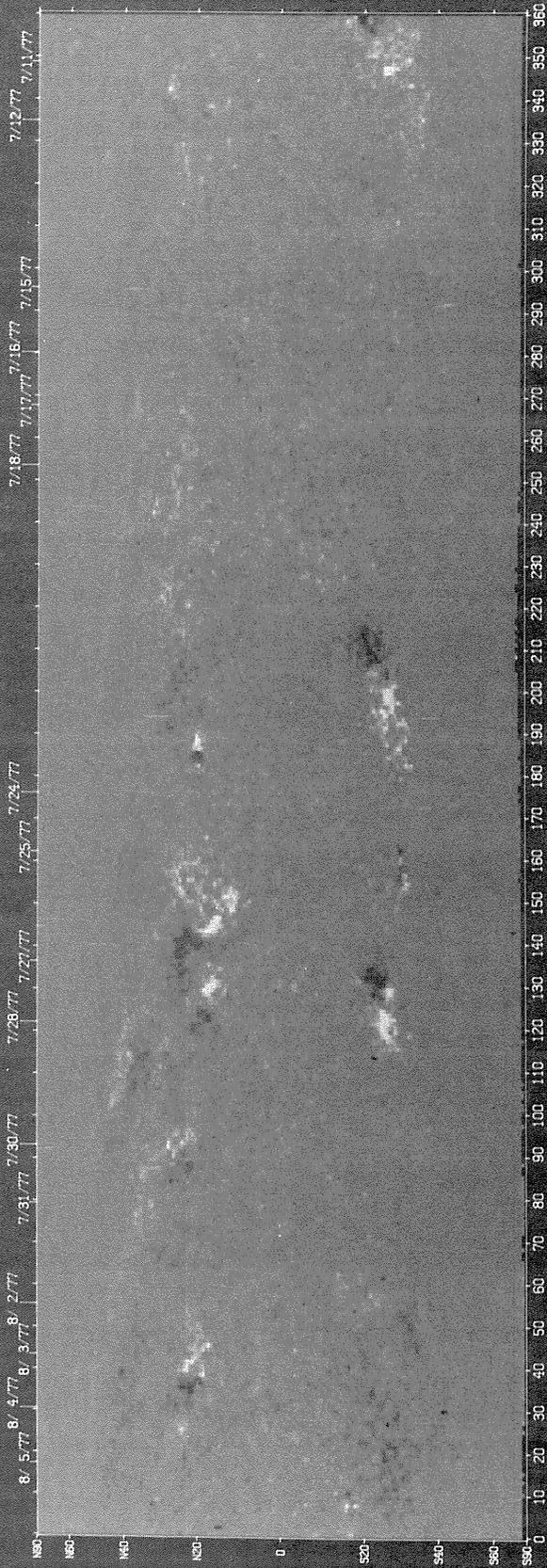


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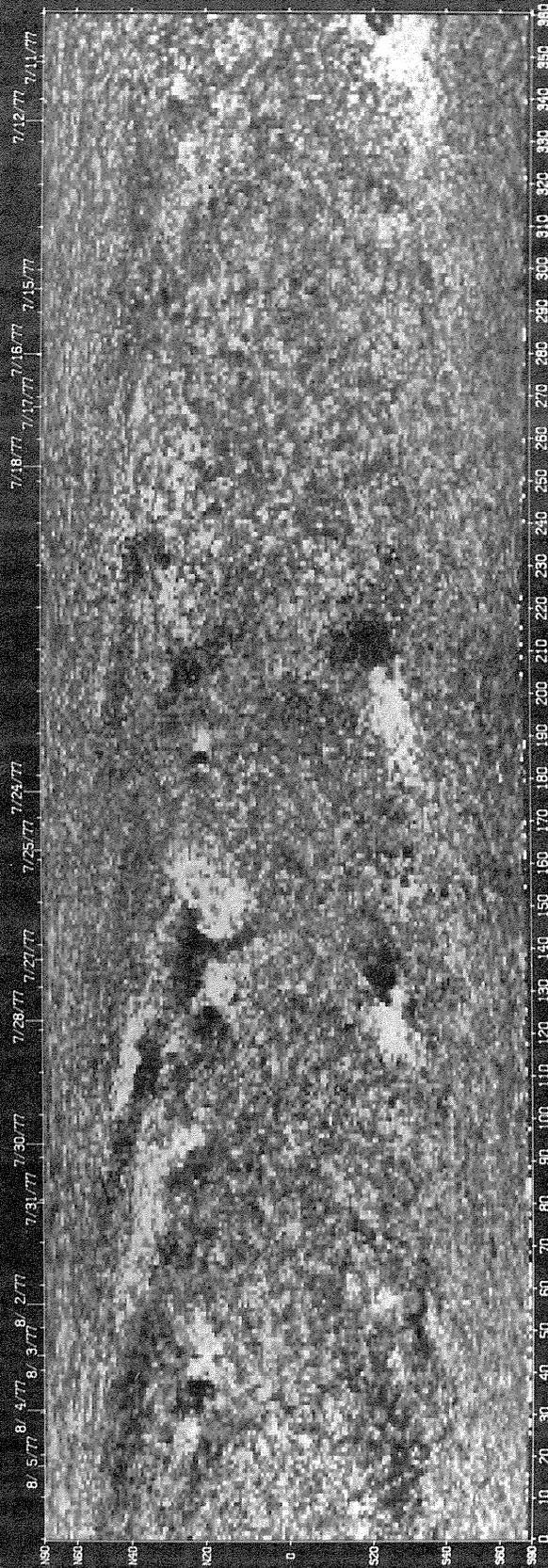


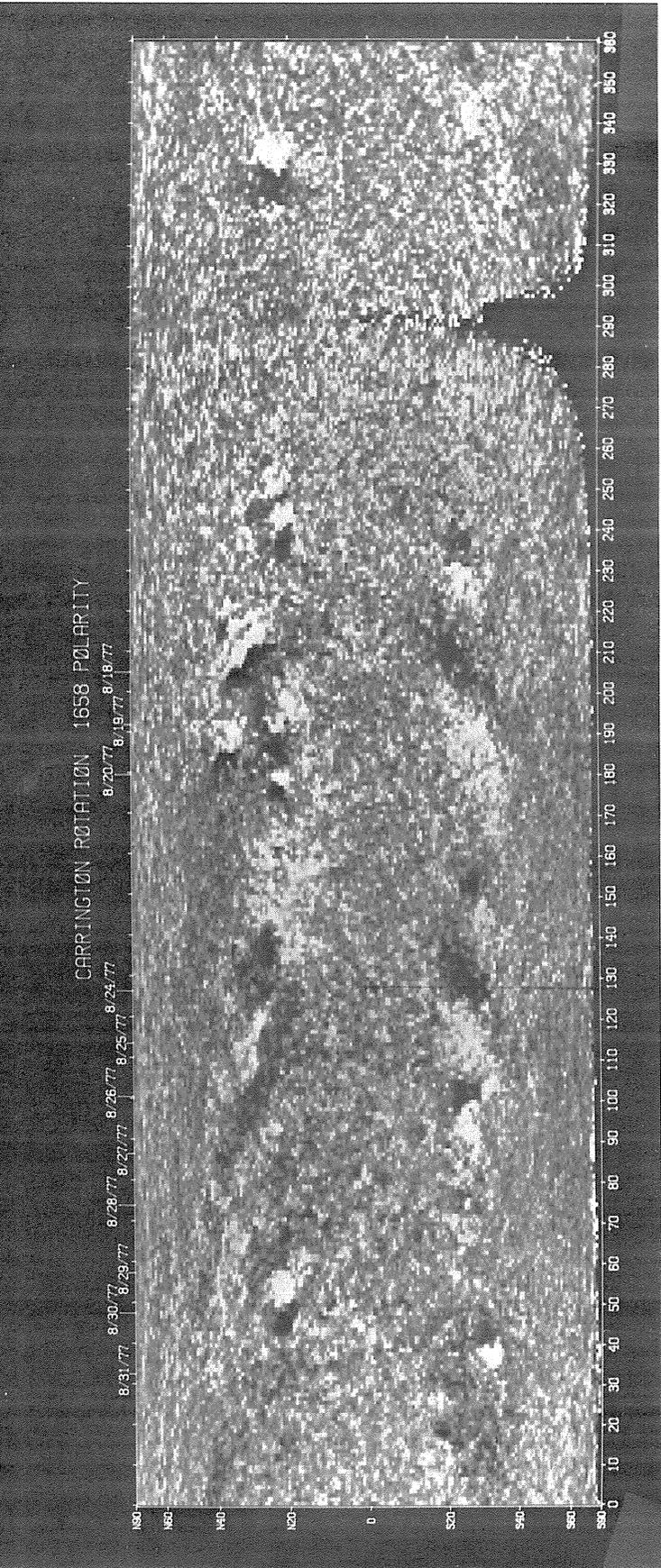
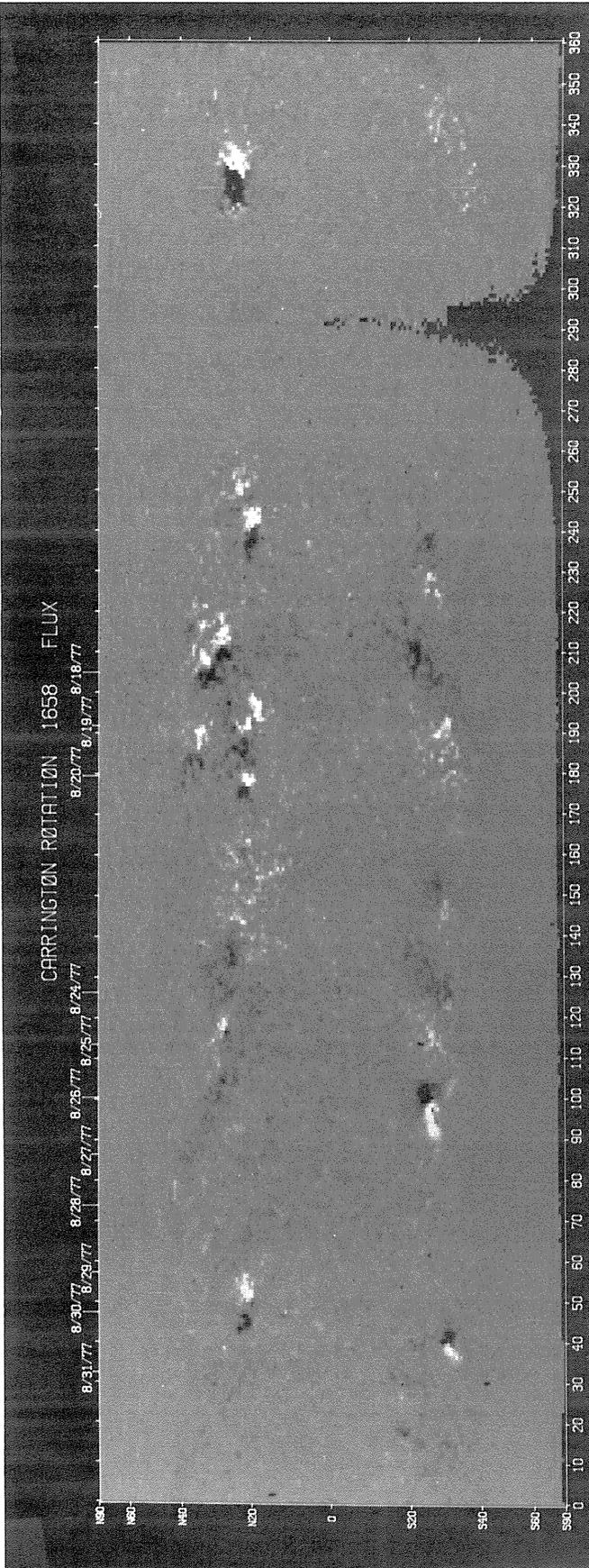


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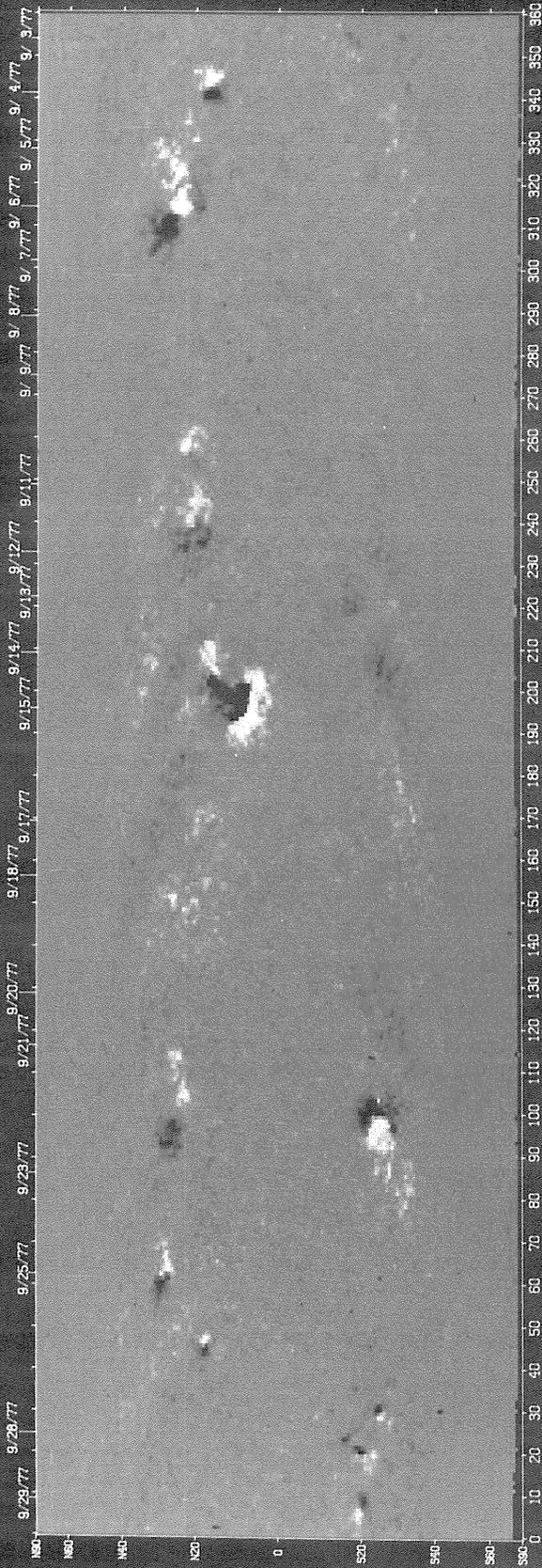


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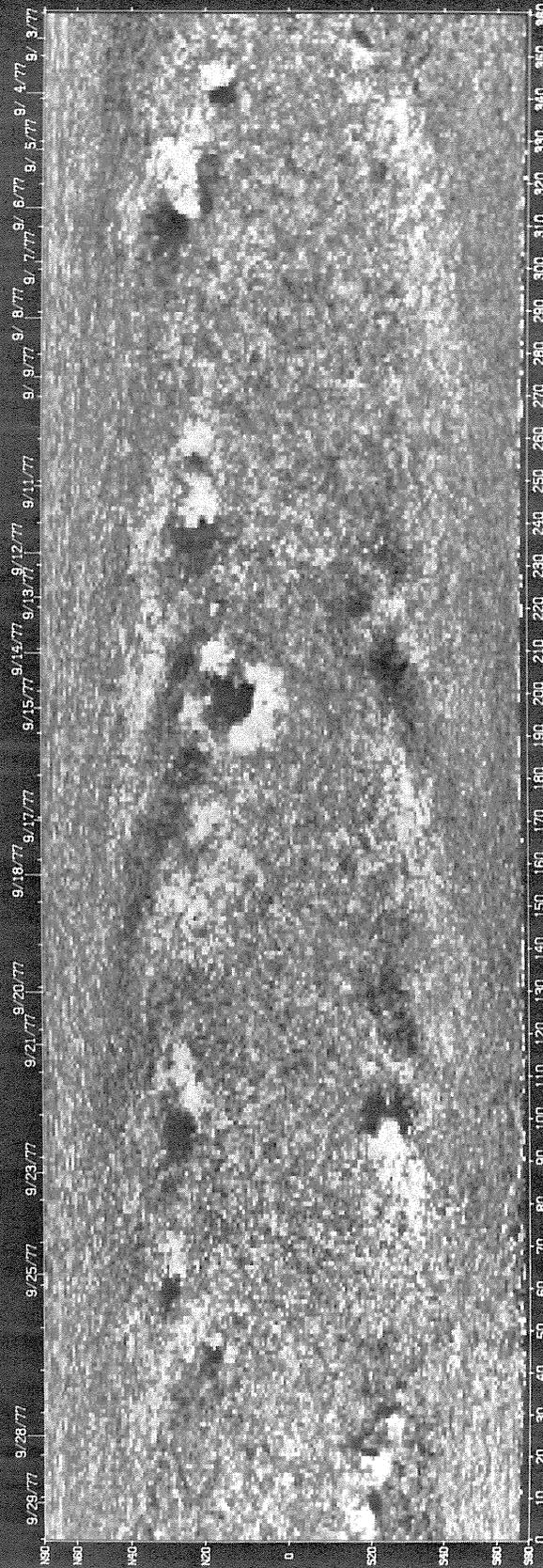


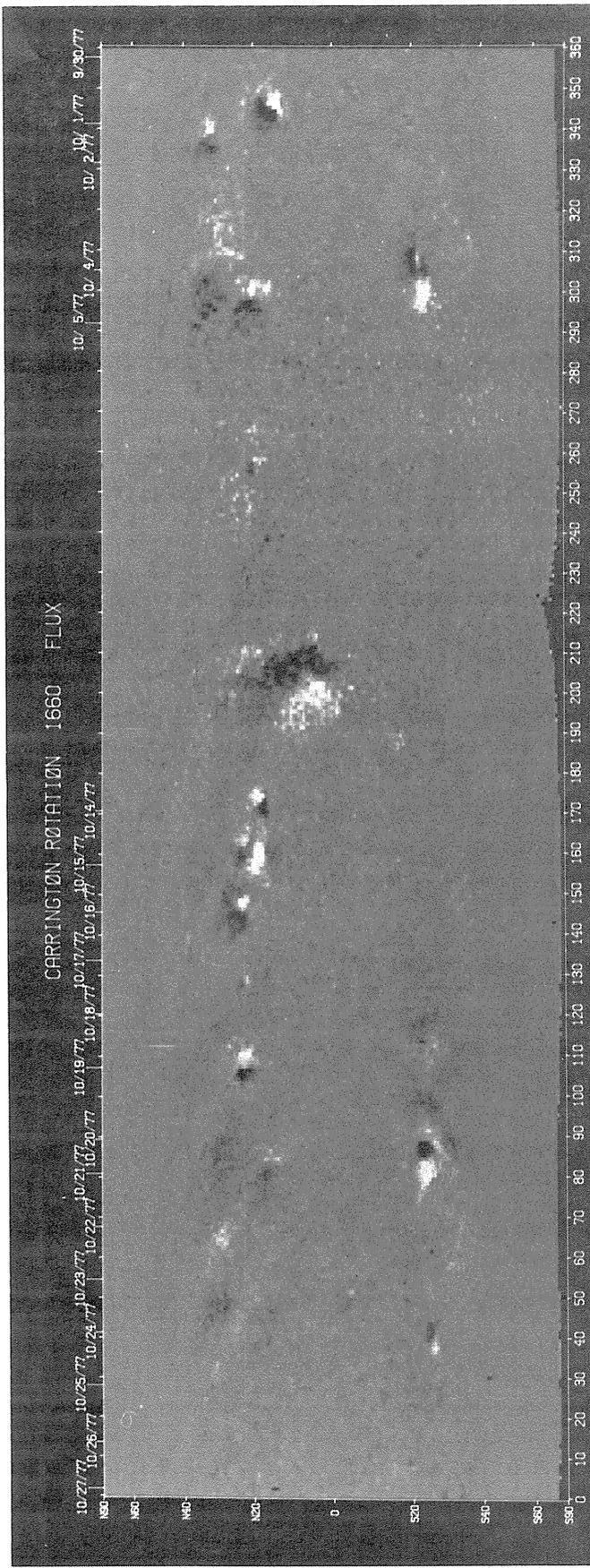


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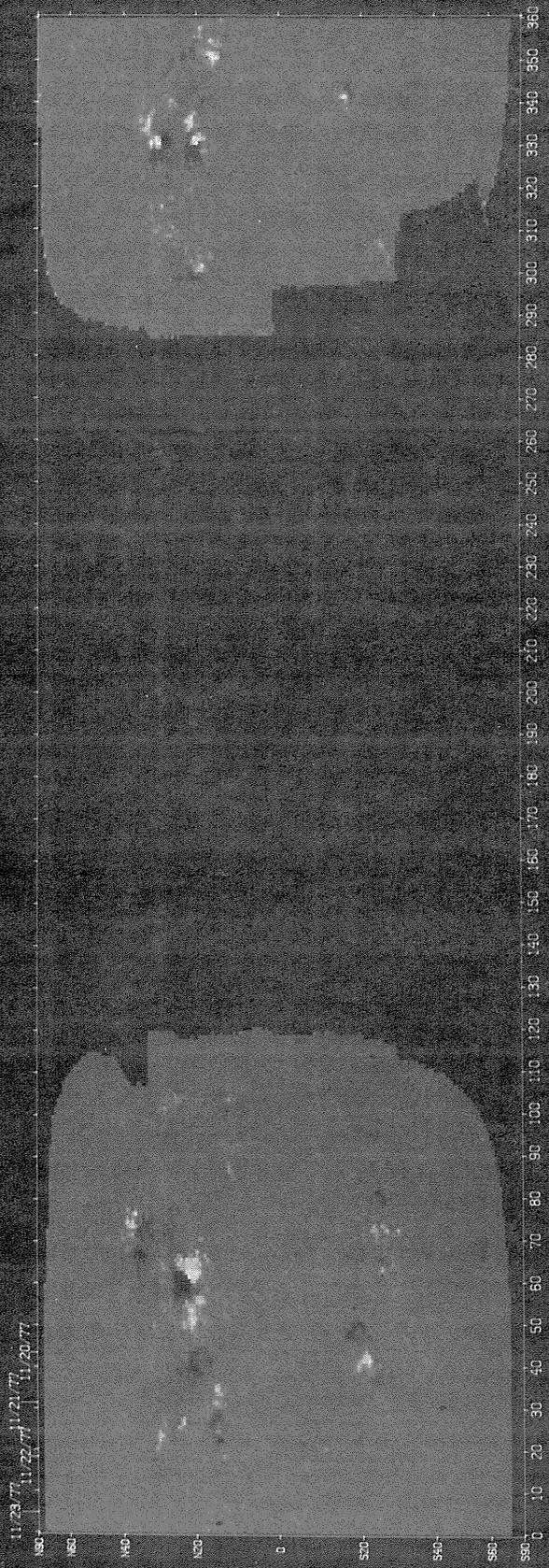


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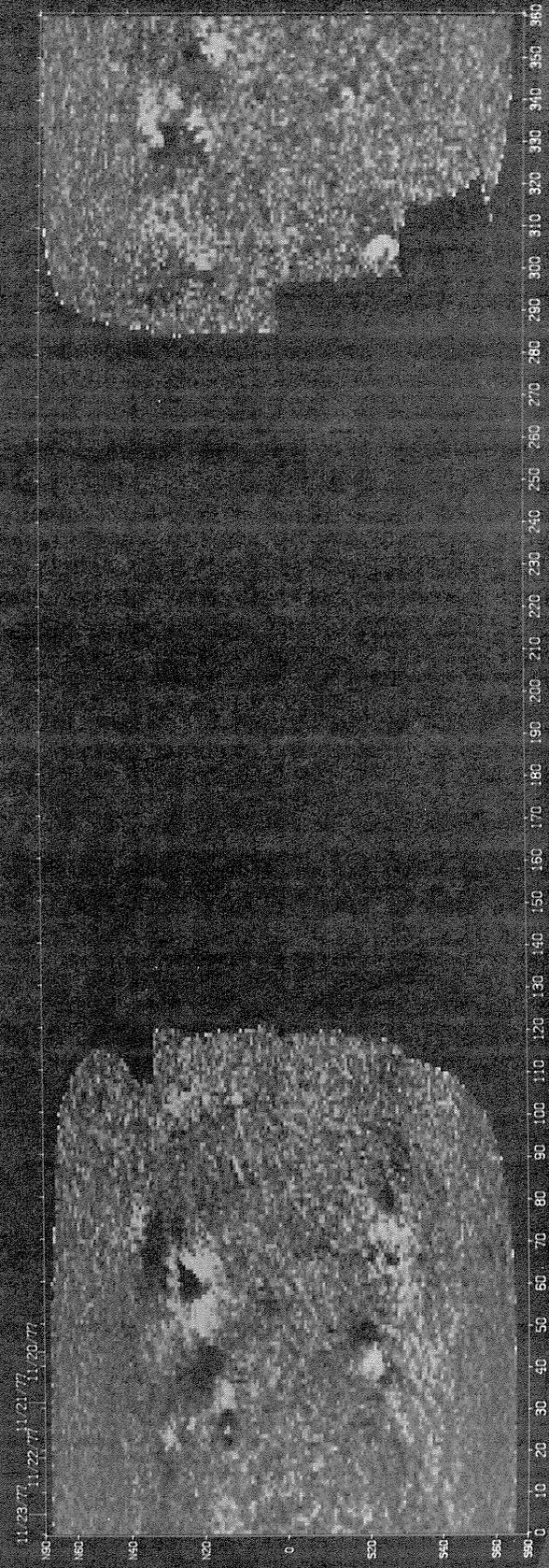


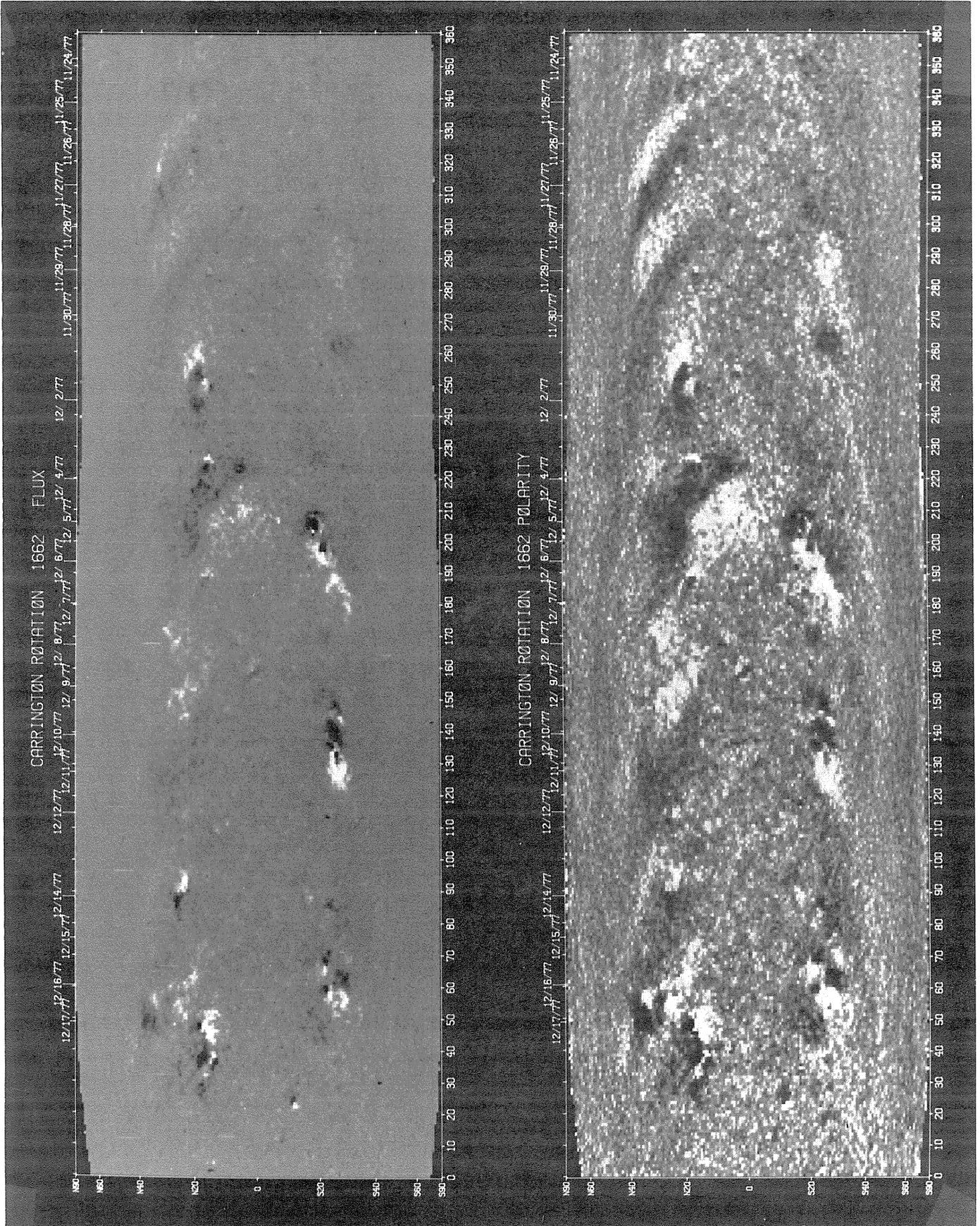


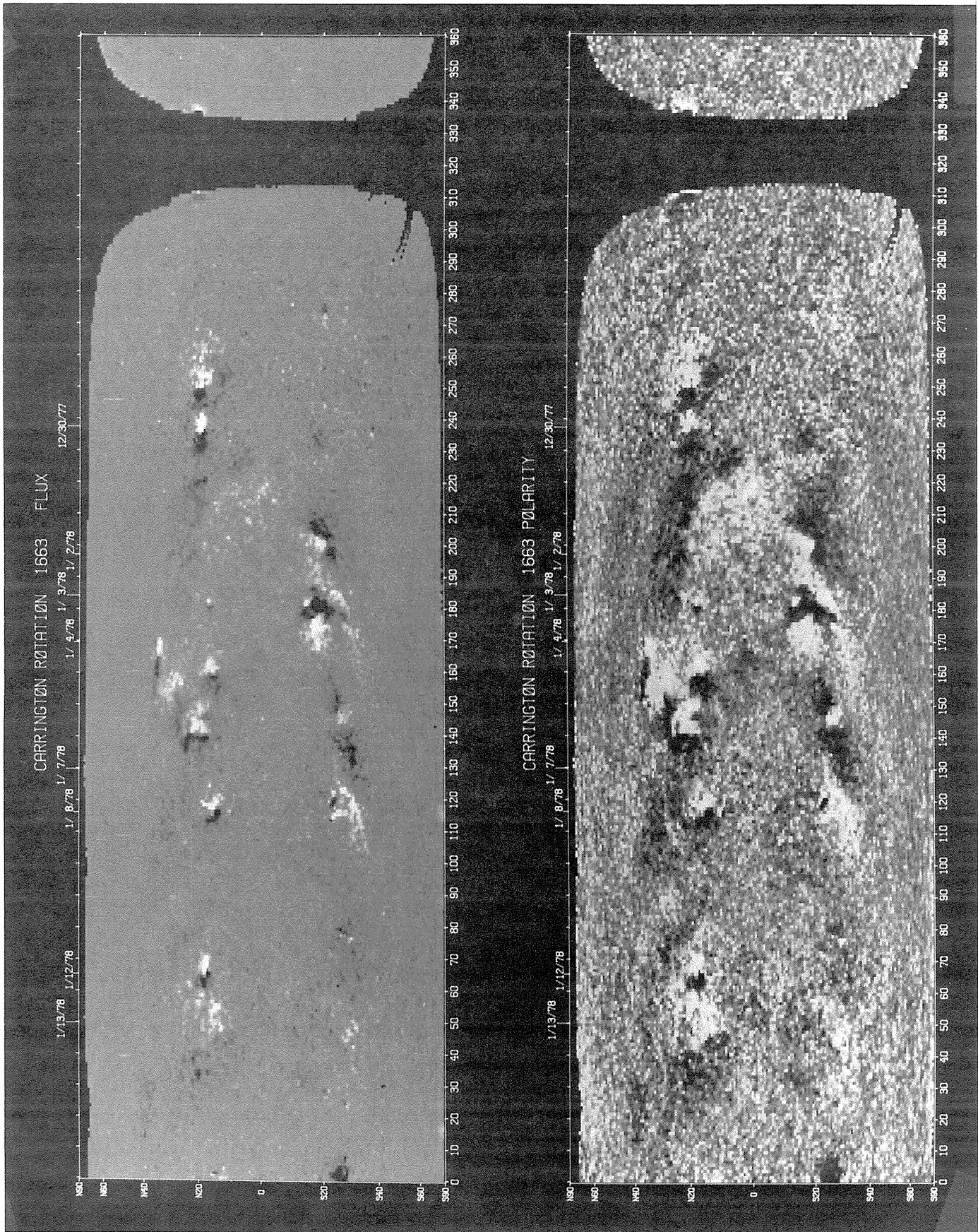
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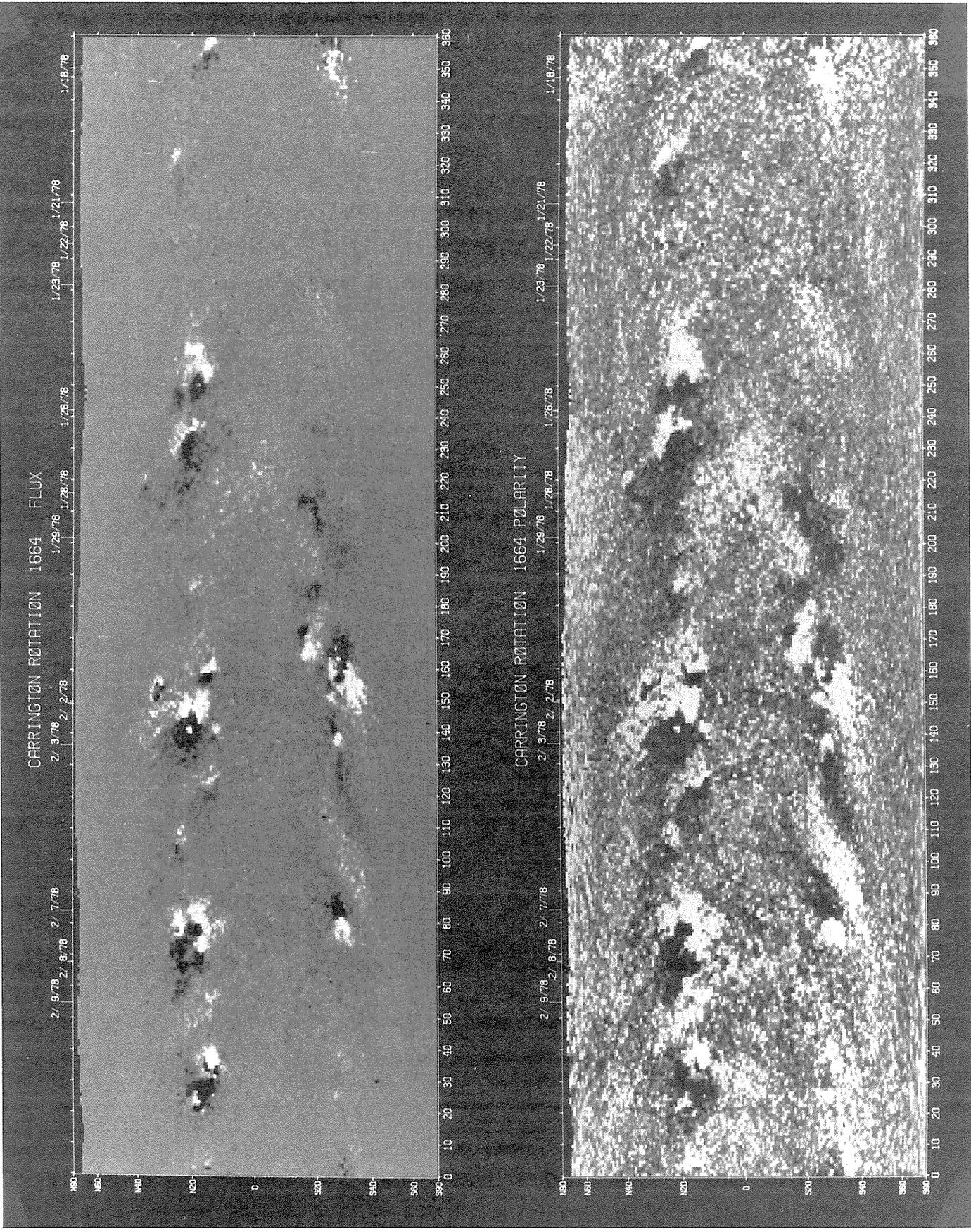


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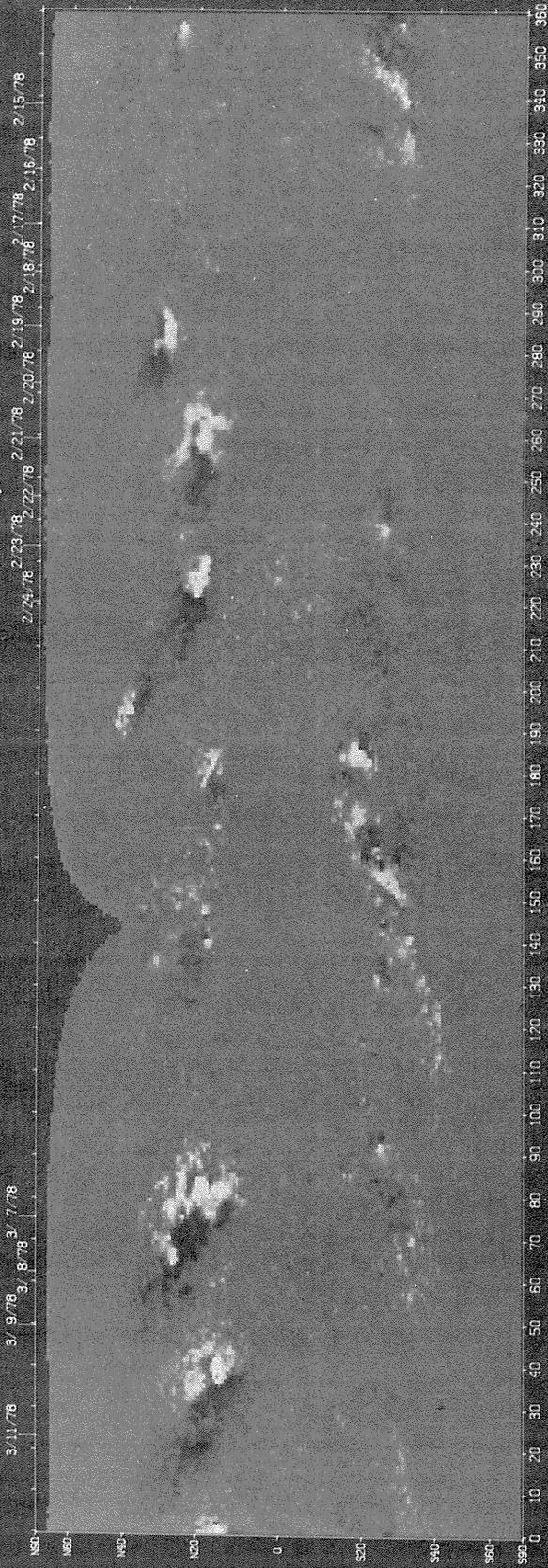








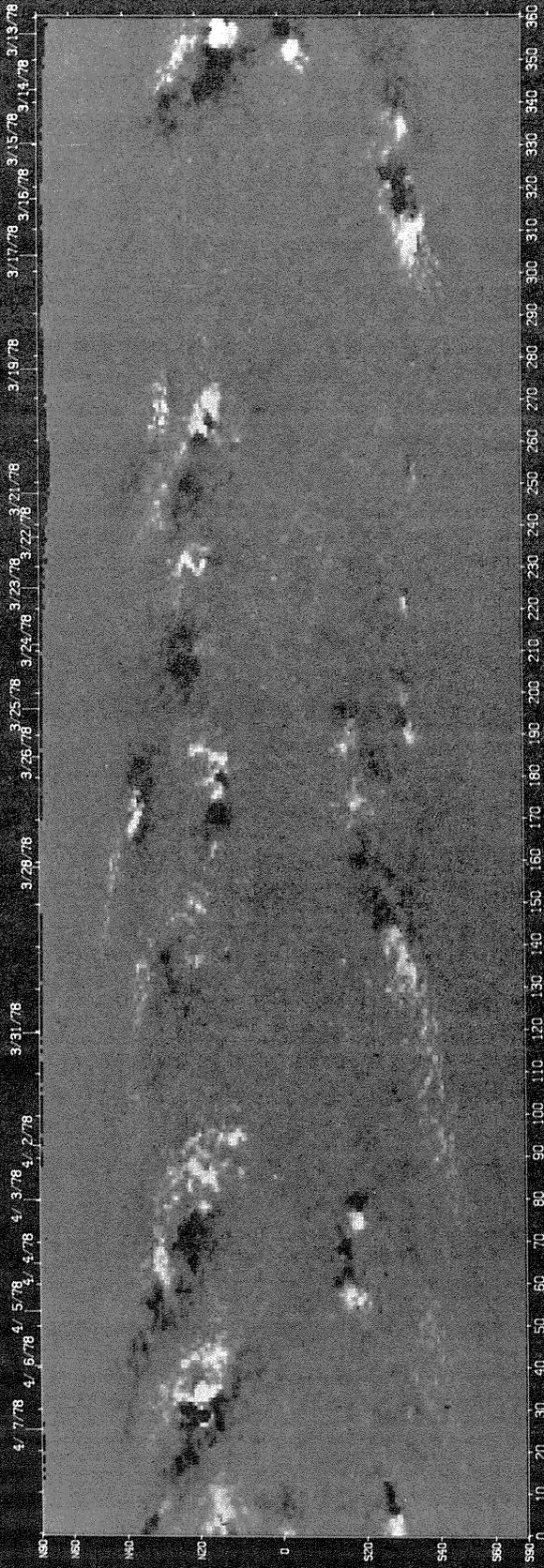
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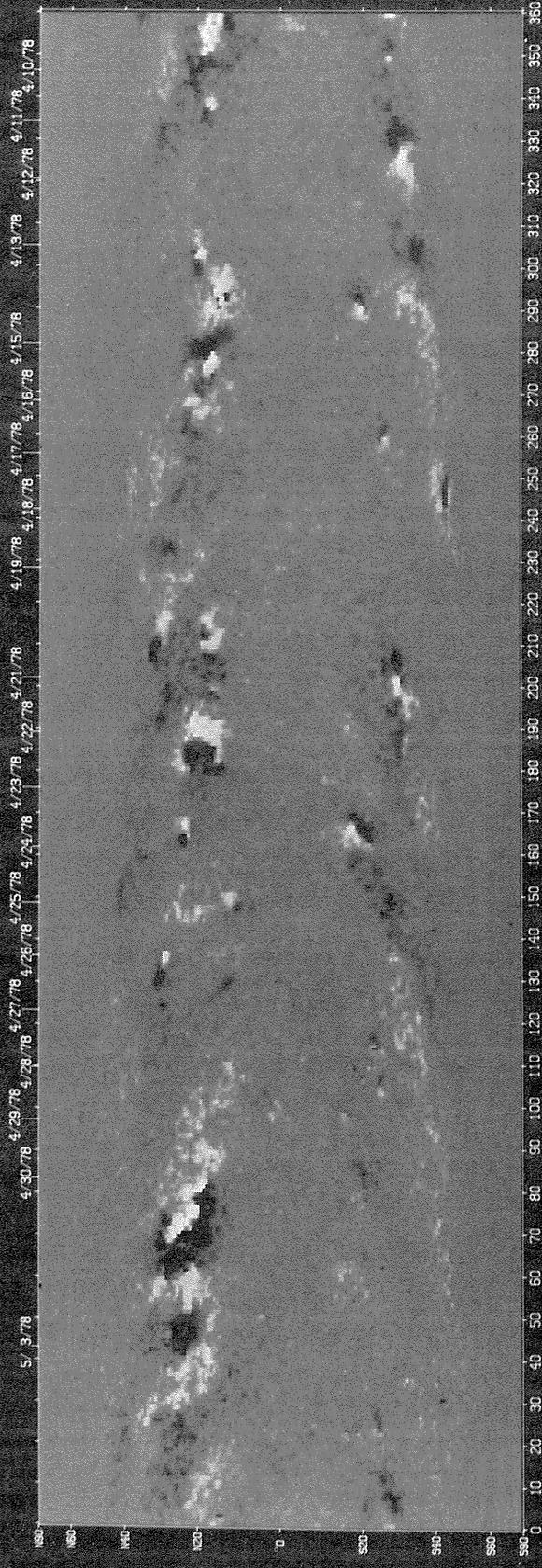
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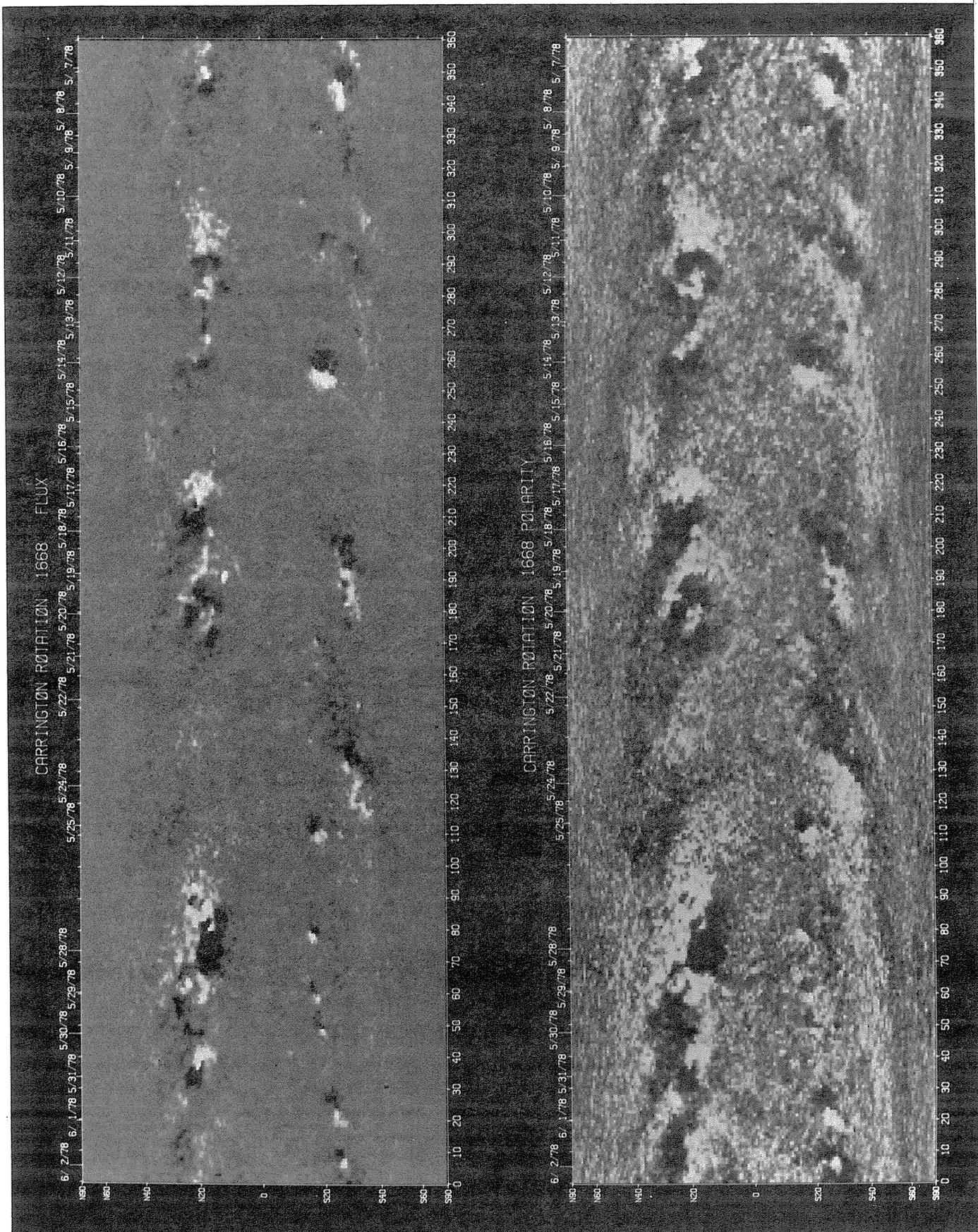


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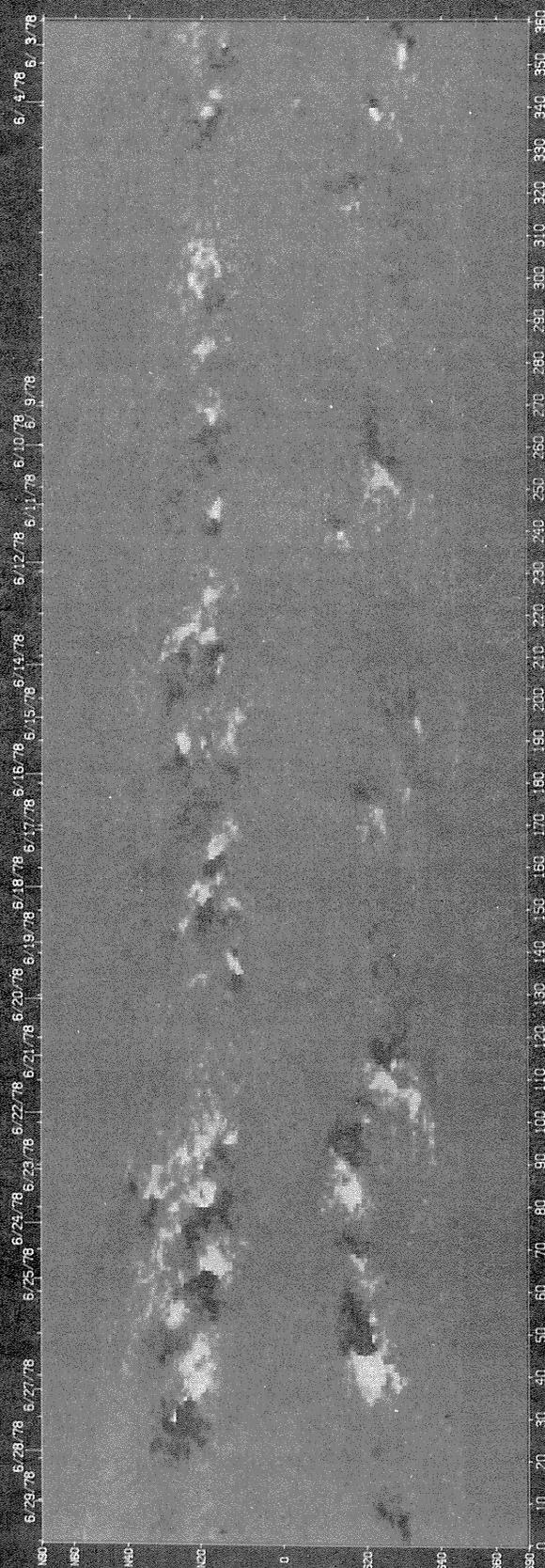


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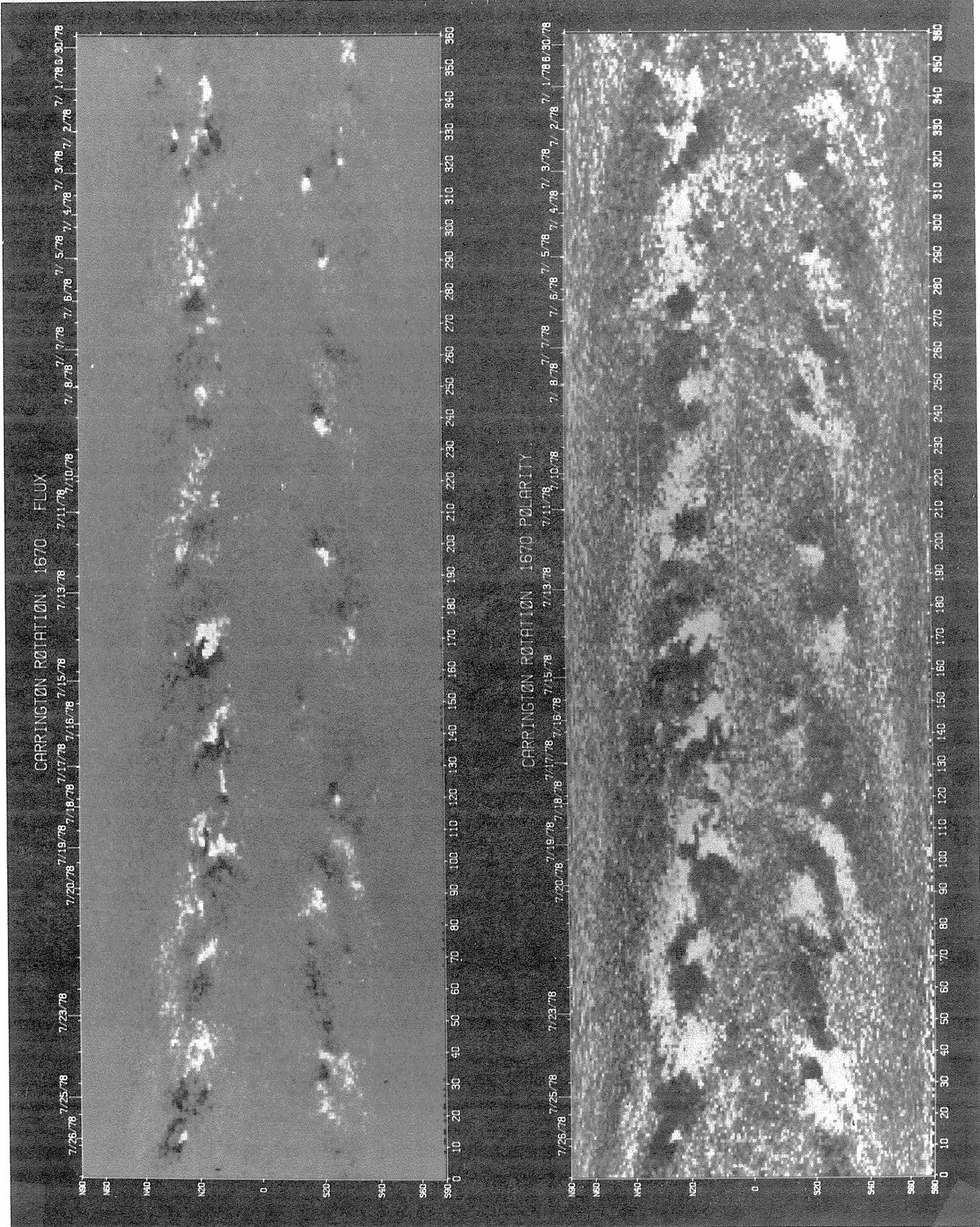


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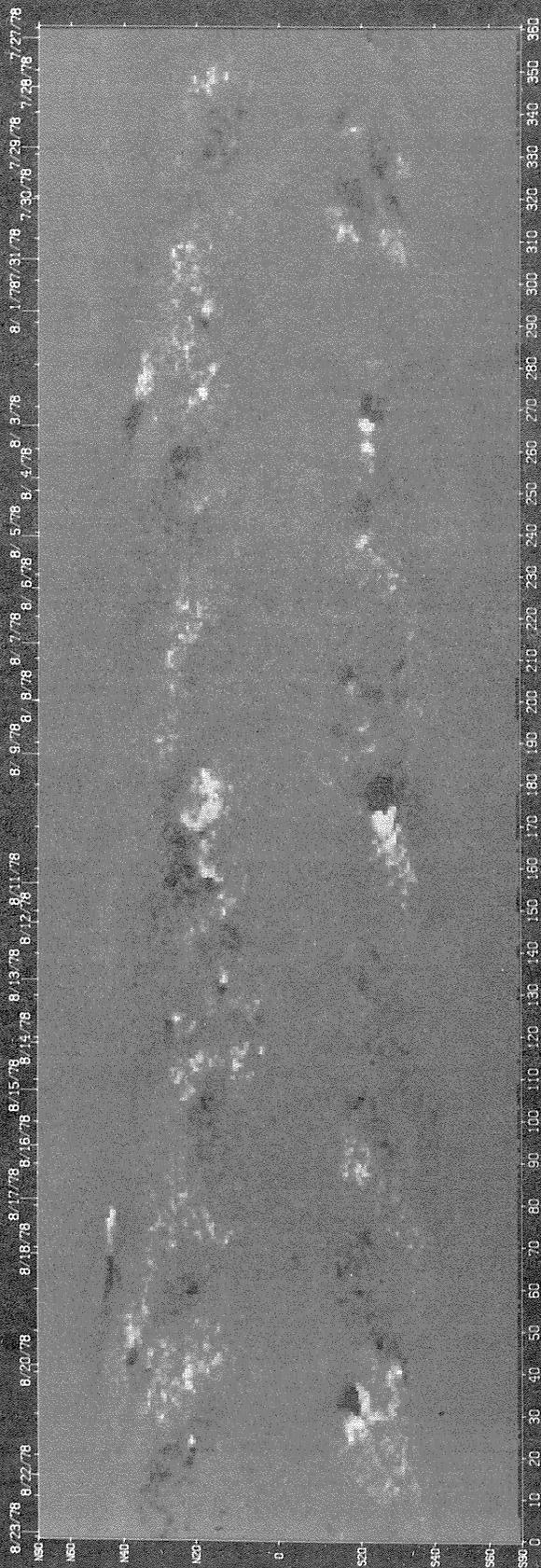


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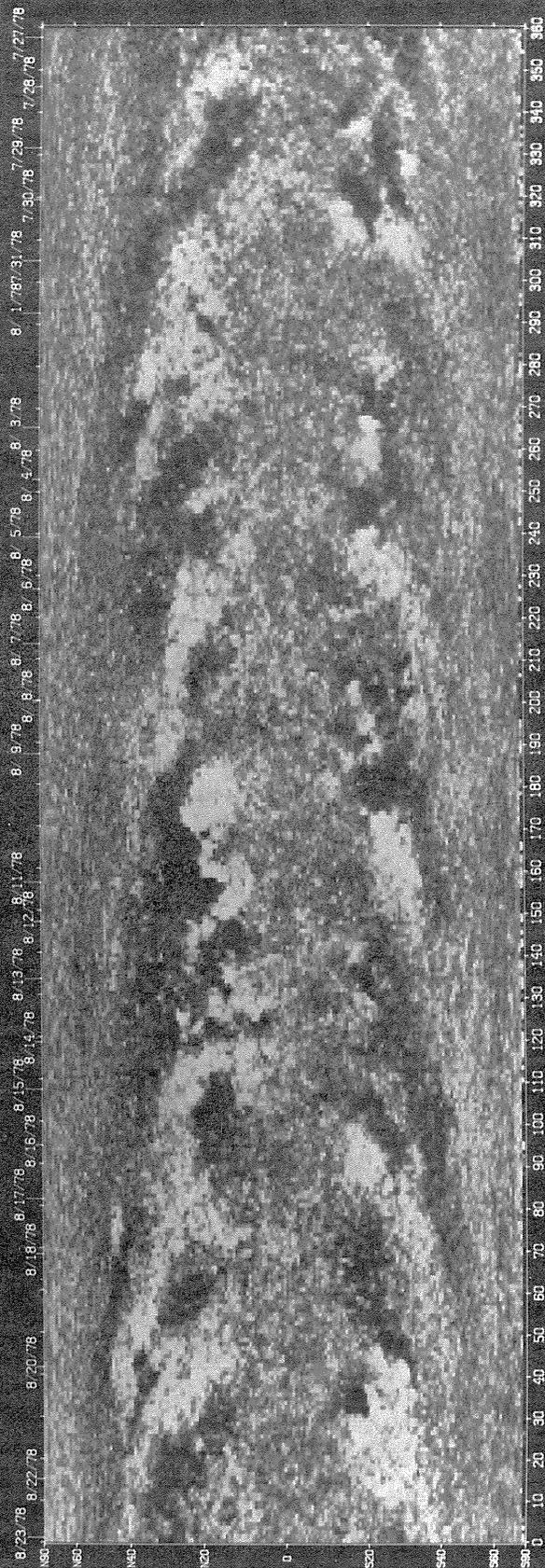




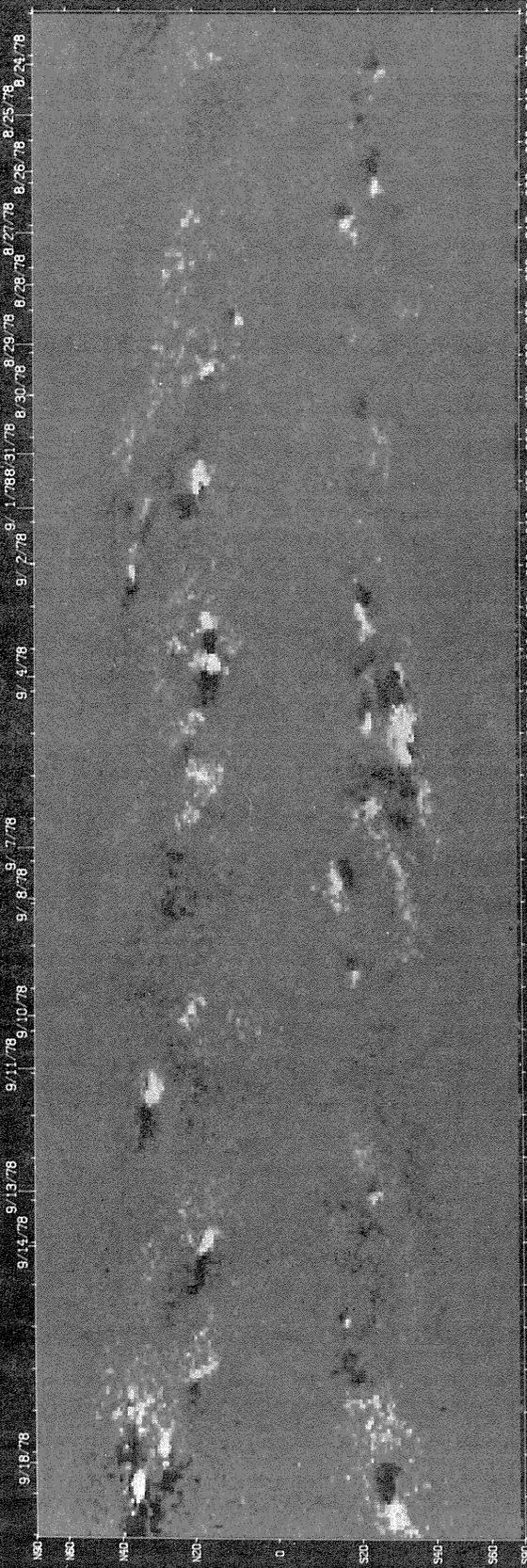
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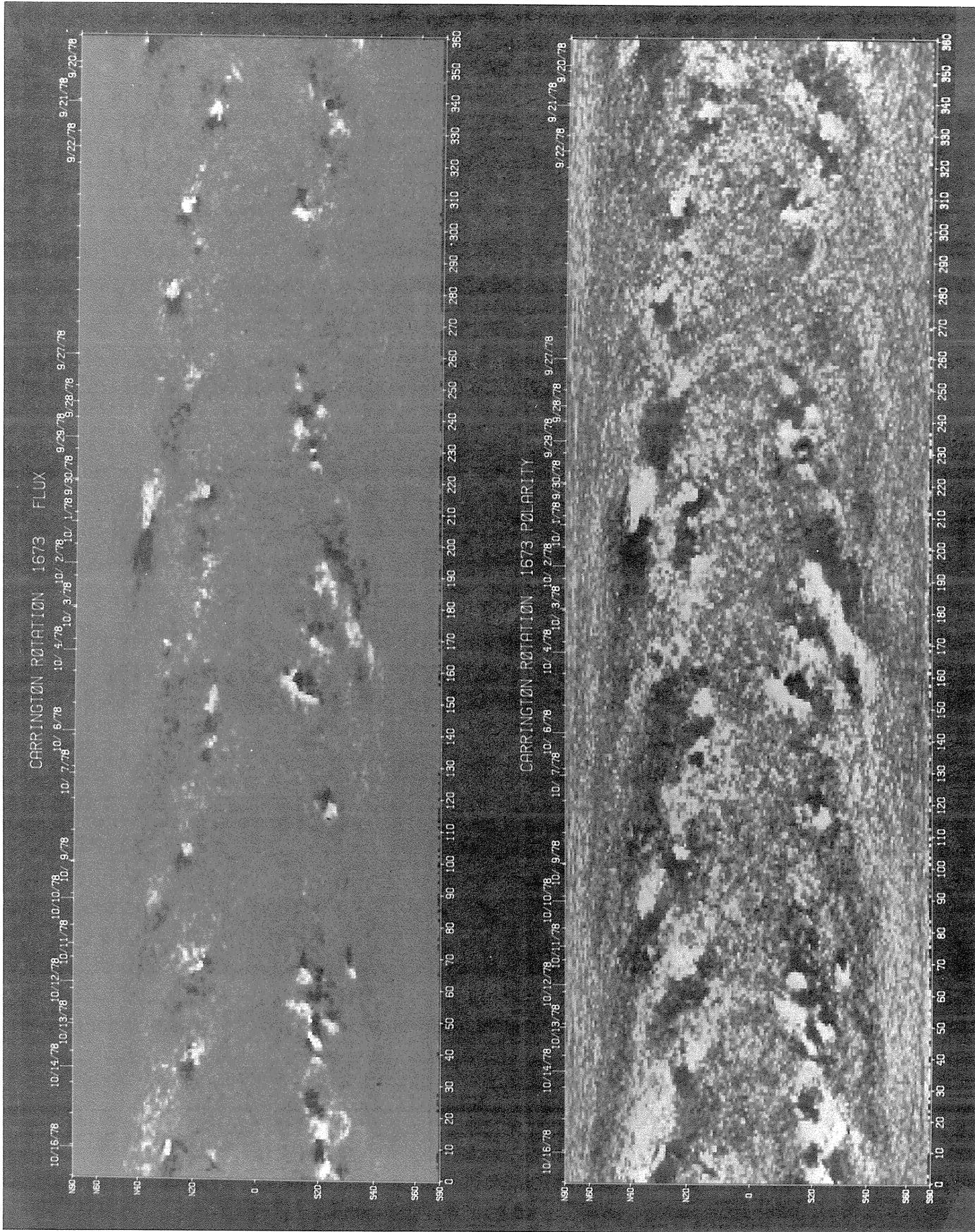


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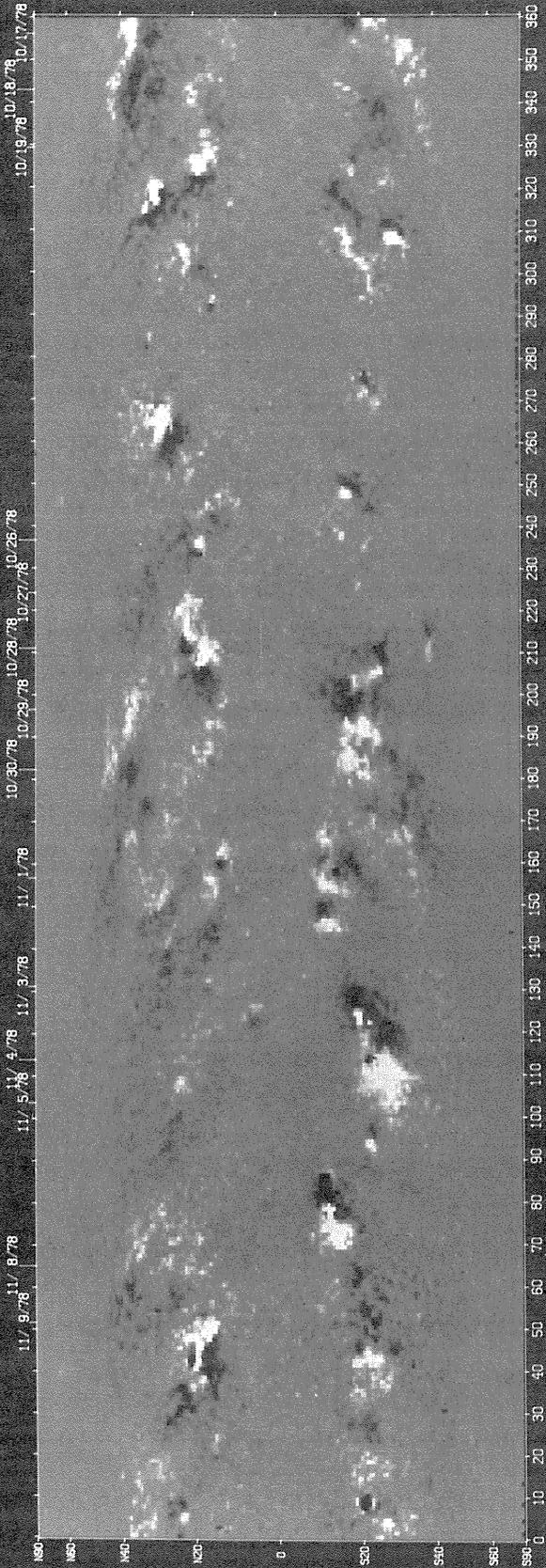


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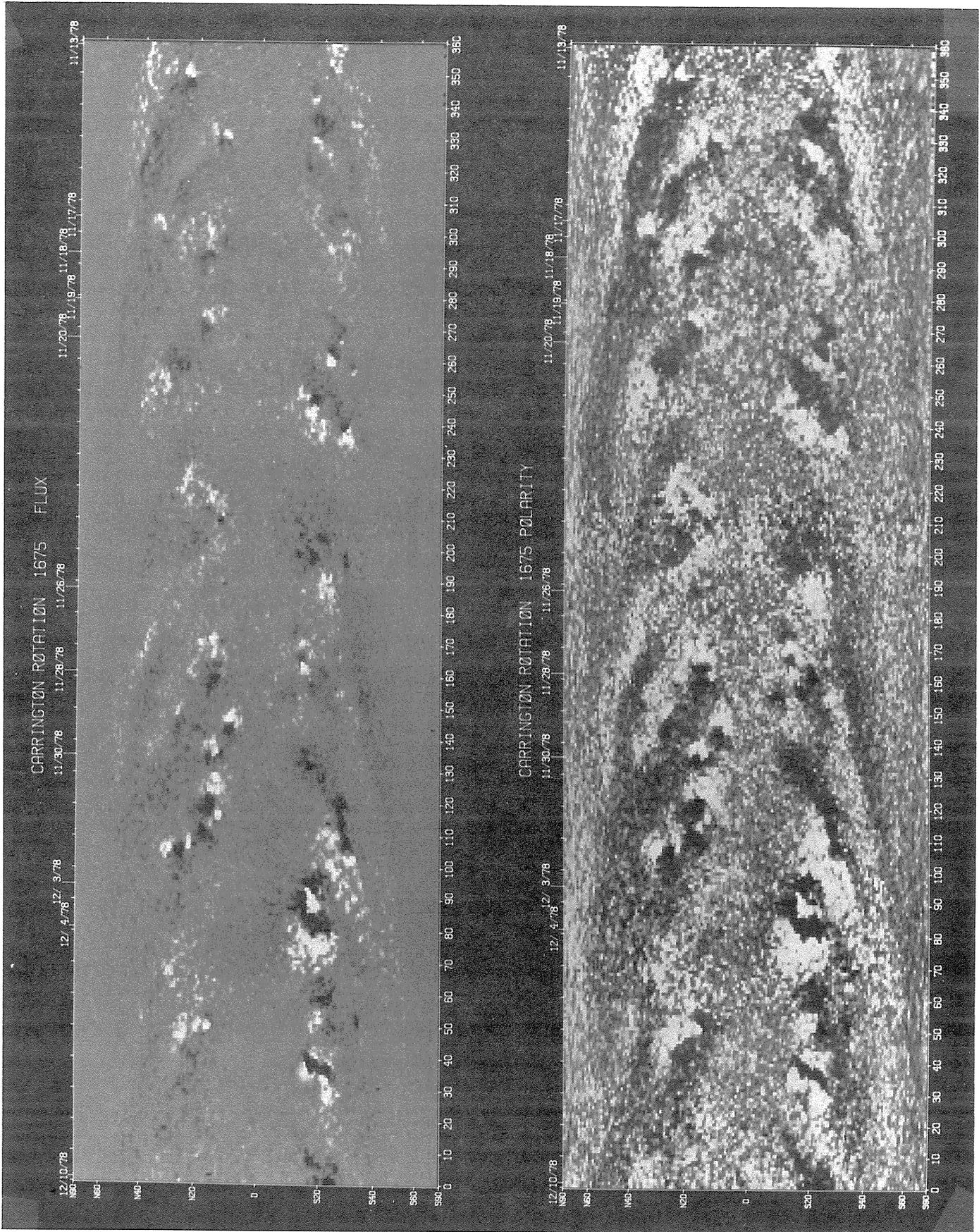


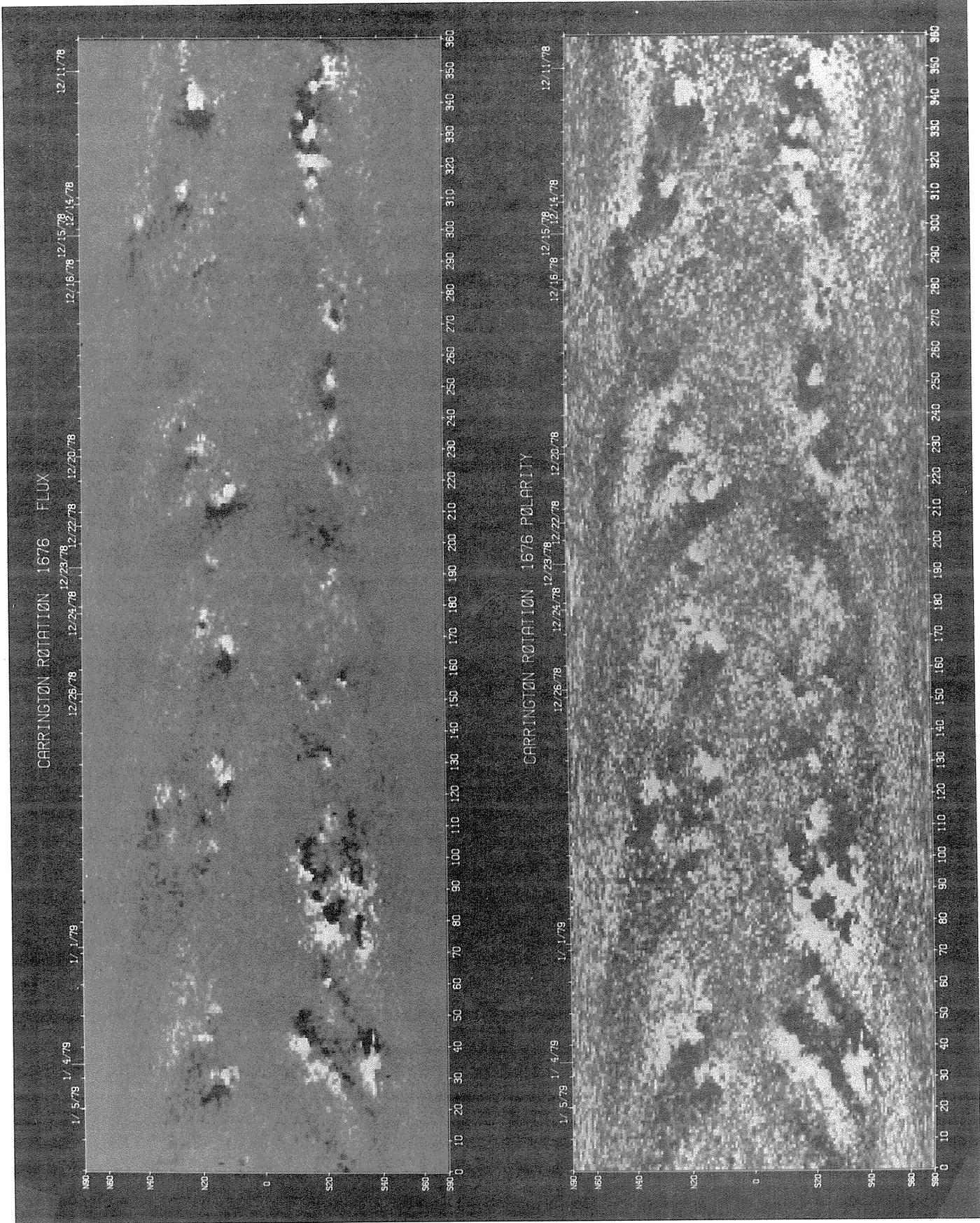
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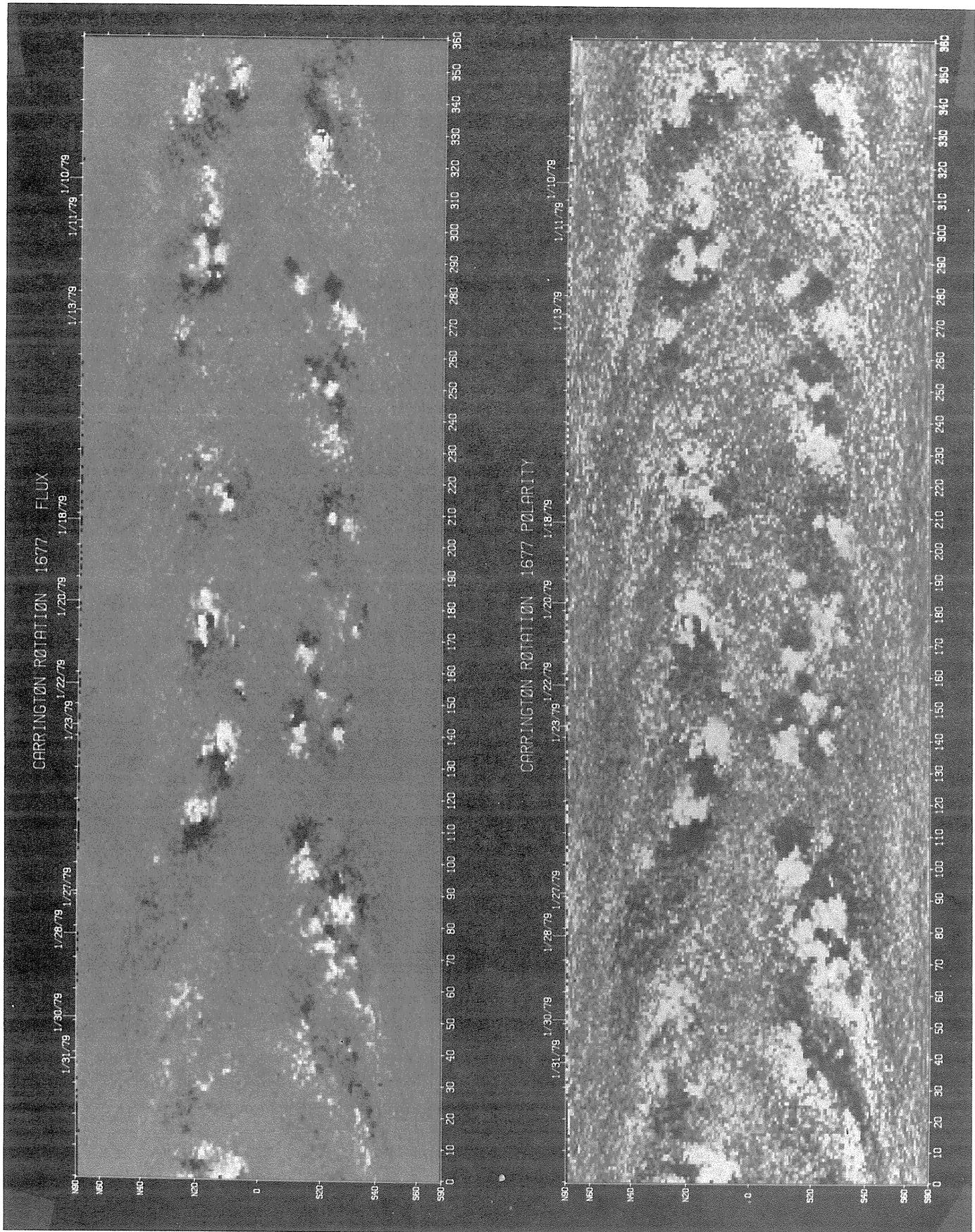


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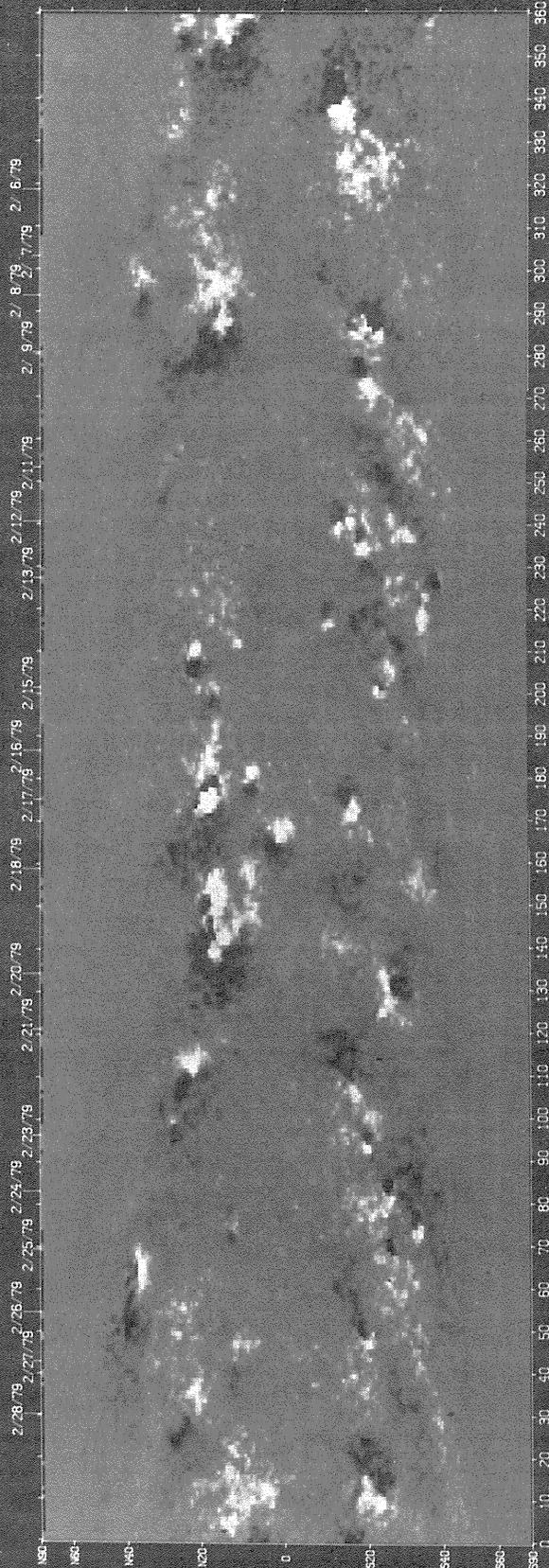




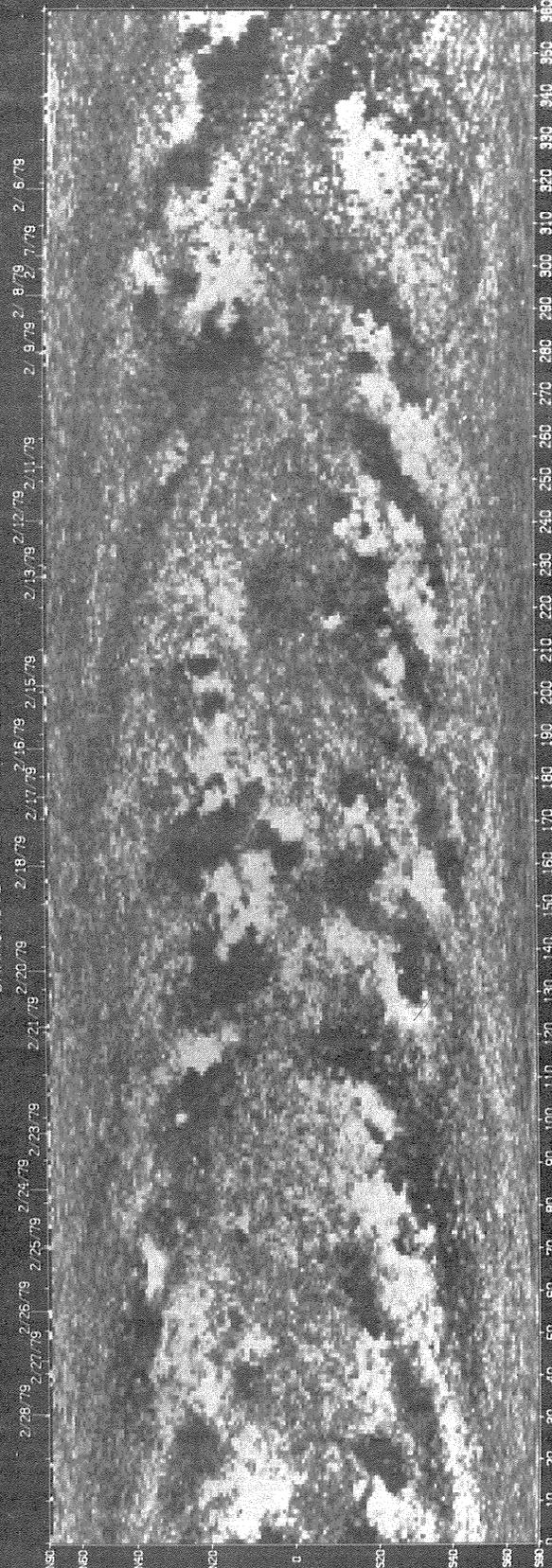




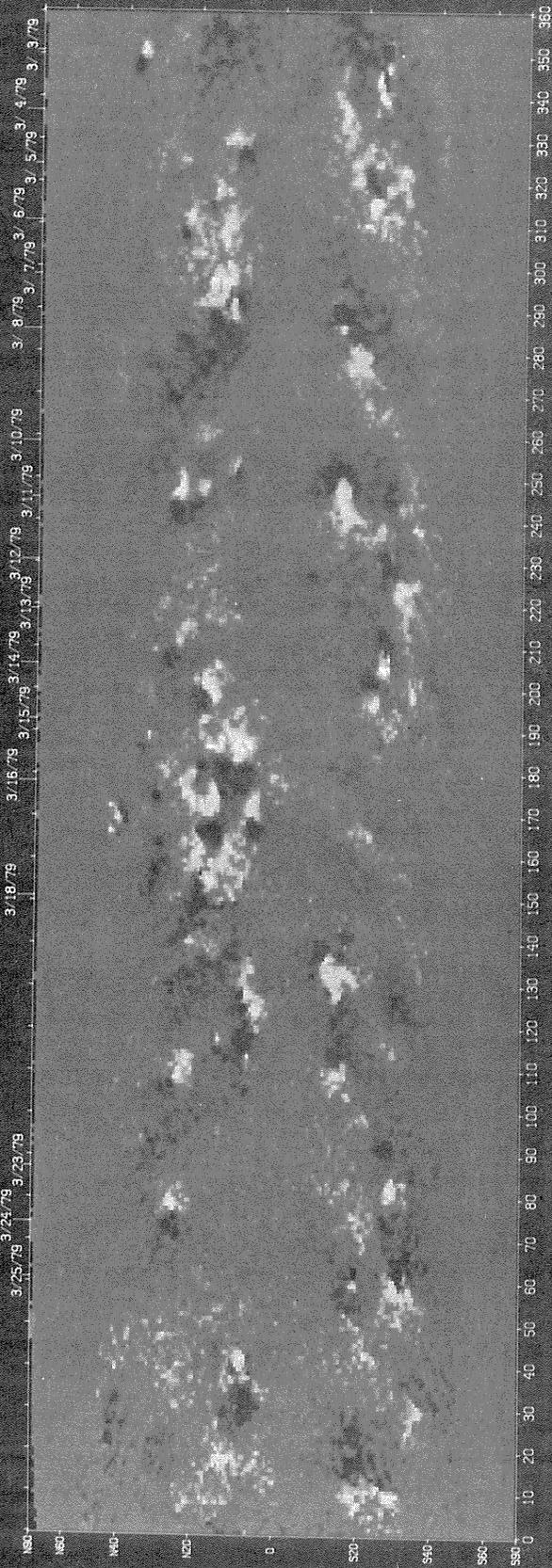
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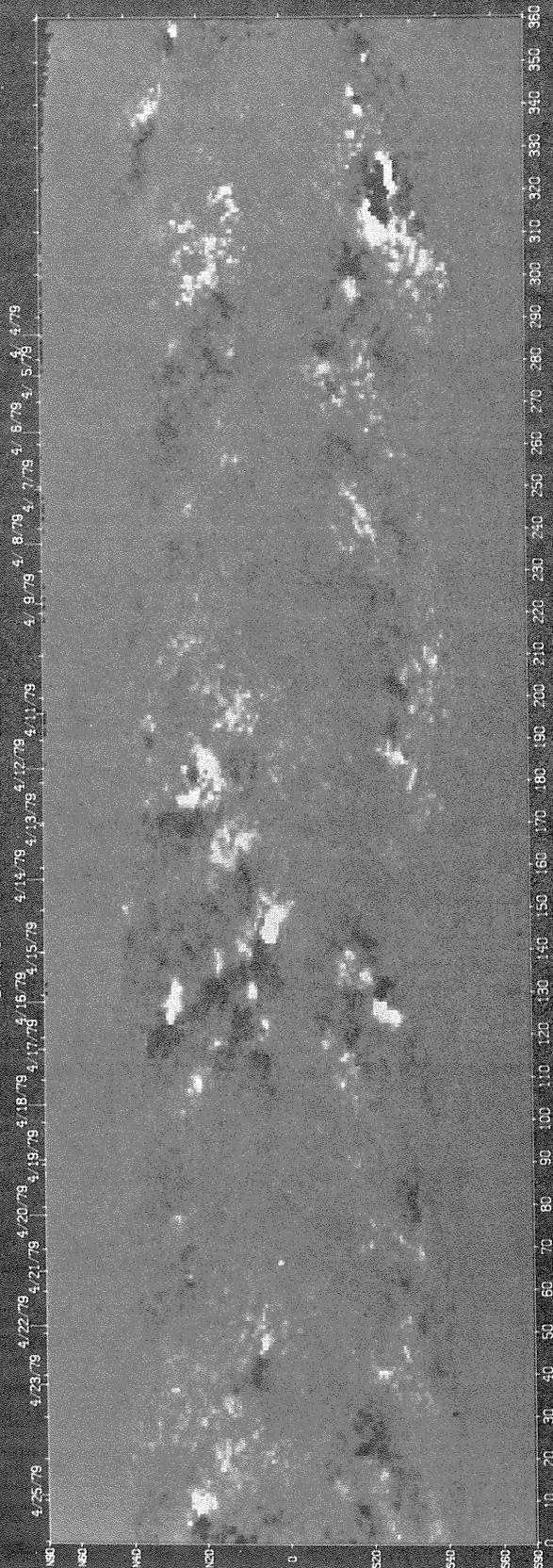
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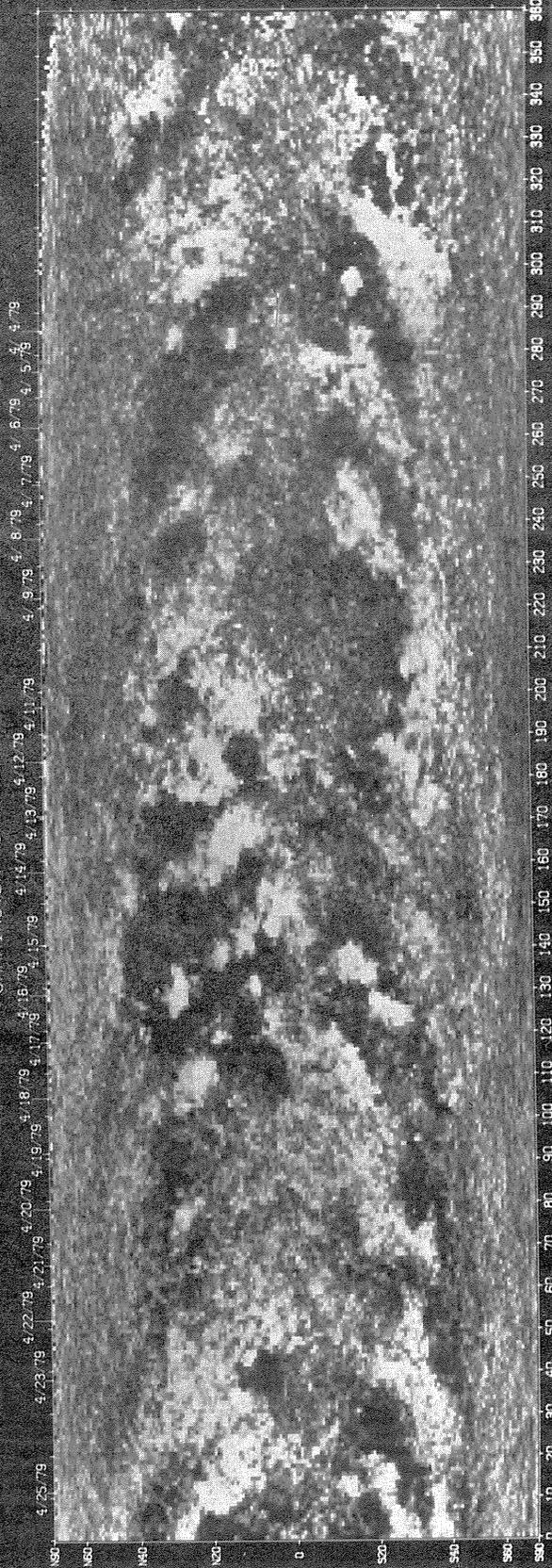
CARRINGTON ROTATION 1679 POLARITY



CARRINGTON ROTATION 1680 FLUX



CARRINGTON ROTATION 1680 POLARITY



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