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ACTIVE REGION EVOLUTION IN THE CHROMOSPHERE AND TRANSTITION REGION

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ABSTRACT

Images in the C IV 1548Å and the Si II 1526Å lines taken with the Ultra-violet Spectrometer Polarimeter (UVSP) instrument on board the *Solar Maximum Mission* (SMM) satellite have been combined into movies showing the evolution of active regions and the neighboring supergranulation over several days. The data sets generally consist of 240 by 240 arc second rasters with 3 arc second pixels taken once per orbit (about every 90 minutes). The images are projected on a latitude/longitude grid to remove the forshortening as the region rotates across the solar disk and further processed to remove jitter and gain variations. Movies have been made with and without differential rotation. Although there are occasional missing orbits, these series do not suffer from the long nighttime gaps that occur in observations taken at a single groundbased observatory and are excellent for studying changes on time scales of several hours. The longest sequence processed to date runs from 20-Oct-1980 to 25-Oct-1980. This was taken during an SMM flare buildup study on AR 2744. Several shorter sequences taken in 1980 and 1984 will also be shown. The results will be presented on a video disk which can be interactively controlled to view the movies.

One of the scientific objectives during the *Solar Maximum Mission* (SMM) observations of 1980 was to study the morphology and evolution of active regions. During some periods, a special effort was made to obtain consistent data sets on an active region for several days with a large field of view. For the Ultra-violet Spectrometer Polarimeter (UVSP) instrument, the operating mode in support of this objective was at least one 240" by 240" image of the active region every orbit. We have developed software to process these images and to record them on a random access video disk. They are projected on a latitude/longitude grid to remove the foreshortening as the region rotates across the solar disk and further processed to remove jitter and gain variations. They can then be played as movies with variable speed, blinked between images, or just viewed as a single image. We intend to eventually process all of the UVSP large rasters using these techniques.

Movies have only been made using data taken during the interval from 20-Oct-1980 to 25-Oct-1980 (in spite of the optimistic statement in the abstract). This was during an official

Flare Buildup Study (FBS) which was intended to provide a consistent data set on the development of an active region over a disk crossing (about 2 weeks). Reasonably complete coverage was achieved for 5 days as shown in figure 1. Each orbit lasted 90 minutes and this is the spacing between images when the coverage is complete since only one large raster was done per orbit. Each took about 8 minutes to complete and the remainder of the orbit was used for smaller rasters with a higher cadence. This sequence consists of 57 raster pairs in C IV and Si II. C IV is formed at about 100,000 K in the transition region and Si II is formed in the middle to upper chromosphere. Not all of these images were complete or on line center and 5 of them have been omitted in some of the movies to reduce distractions. Both of these lines were observed with a square 3" entrance slit and a 0.3 Å exit slit. The intensity range is very great, especially in C IV where the brightest points may be hundreds of time more intense than the average. The range was decreased for the displays using a gamma of 0.5 for Si II and 0.35 for C IV.

Figure 2 shows 4 frames from the movie displaying both lines. The box around each image is a latitude/longitude grid 20 degrees on a side. This is very similar to a sun center projection. These were mapped without differential rotation but there are movies with and without differential rotation and also one showing Si II results for the two cases side by side. The Stonyhurst grid in the lower right has the original image position and size marked. Figure 3 shows two "continuum" images taken during this time span which show the sunspot configuration. These were taken at about 3100Å.

It is clear from the movies that 90 minute time steps are too long to follow much of the activity in the transition region shown by C IV. The bright points and loops are generally different in adjacent frames and the movie gives the appearance of hundreds of small explosions. The details of the fainter loop structures within and outside the active region also change from frame to frame although the general configuration is often similar. Si II is much more stable on these time scales and is better for studying changes in the structure of the active region. One of the most striking things in the Si II movie is the outflow around the sunspot group. The evolution of the supergranulation is also apparent. The pattern within the active region is much more stable than in the quiet areas. The supergranules outside the active region seem to be caught up in flows which push them around on a time scale shorter than their lifetimes. We plan to track them using local correlation tracking techniques similar to those used for tracking granules to investigate possible large scale flow fields.

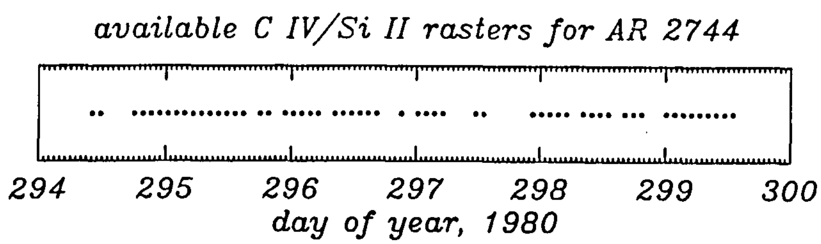

Figure 1. The dots indicate the times of the 57 C IV/Si II rasters in this sequence. Of these, 5 are sufficiently compromised (data dropouts or far off line center) to be distracting in a movie and have been omitted in edited versions of the movies.

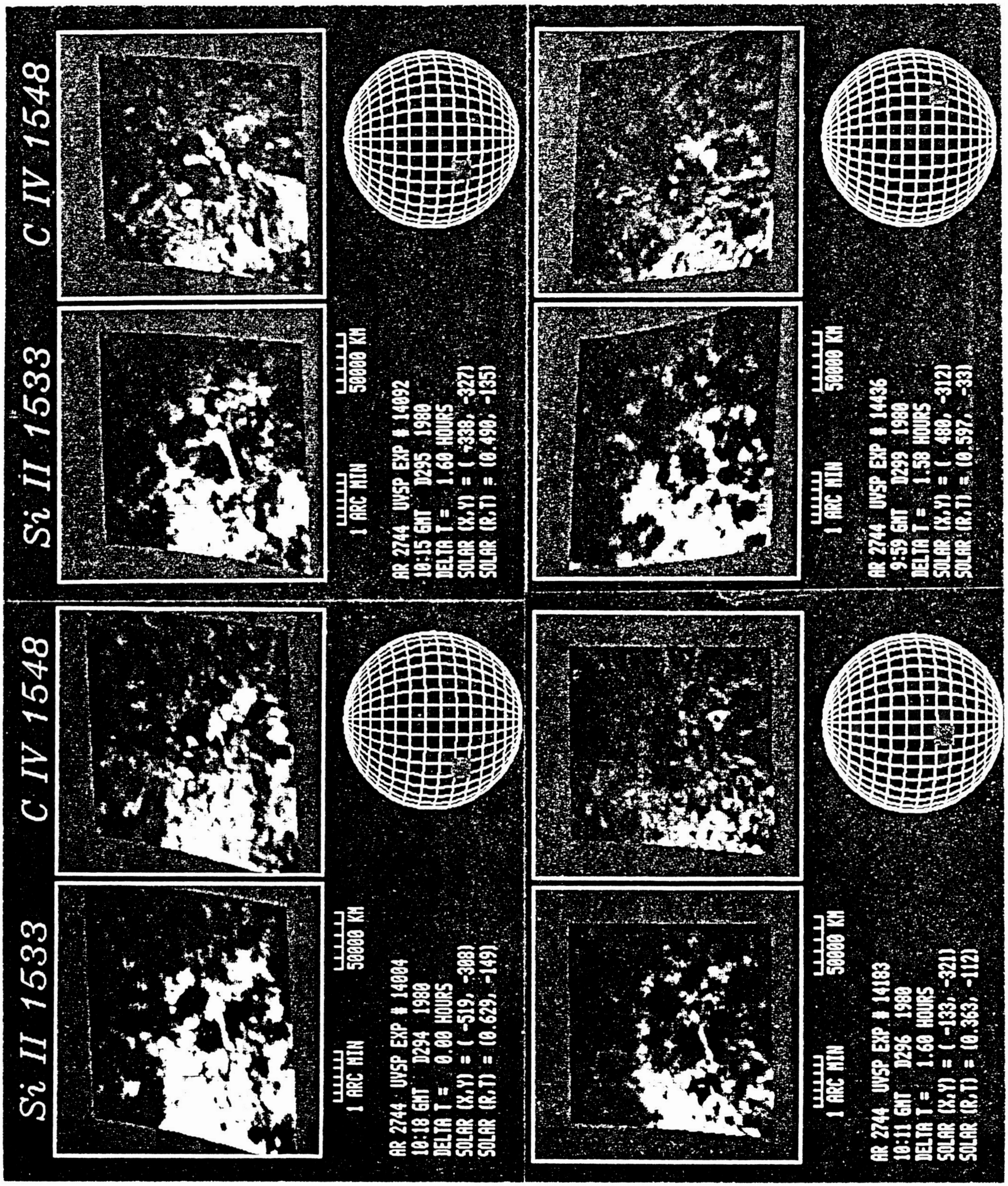

Figure 2. Four of the C IV and Si II rasters (frames 1, 13, 25, and 56 in the movies). The images are mapped onto a latitude/longitude grid 20 degrees on a side. This is very similar to a sun center projection. The Stonyhurst grid in the lower right has the original image position and size marked.

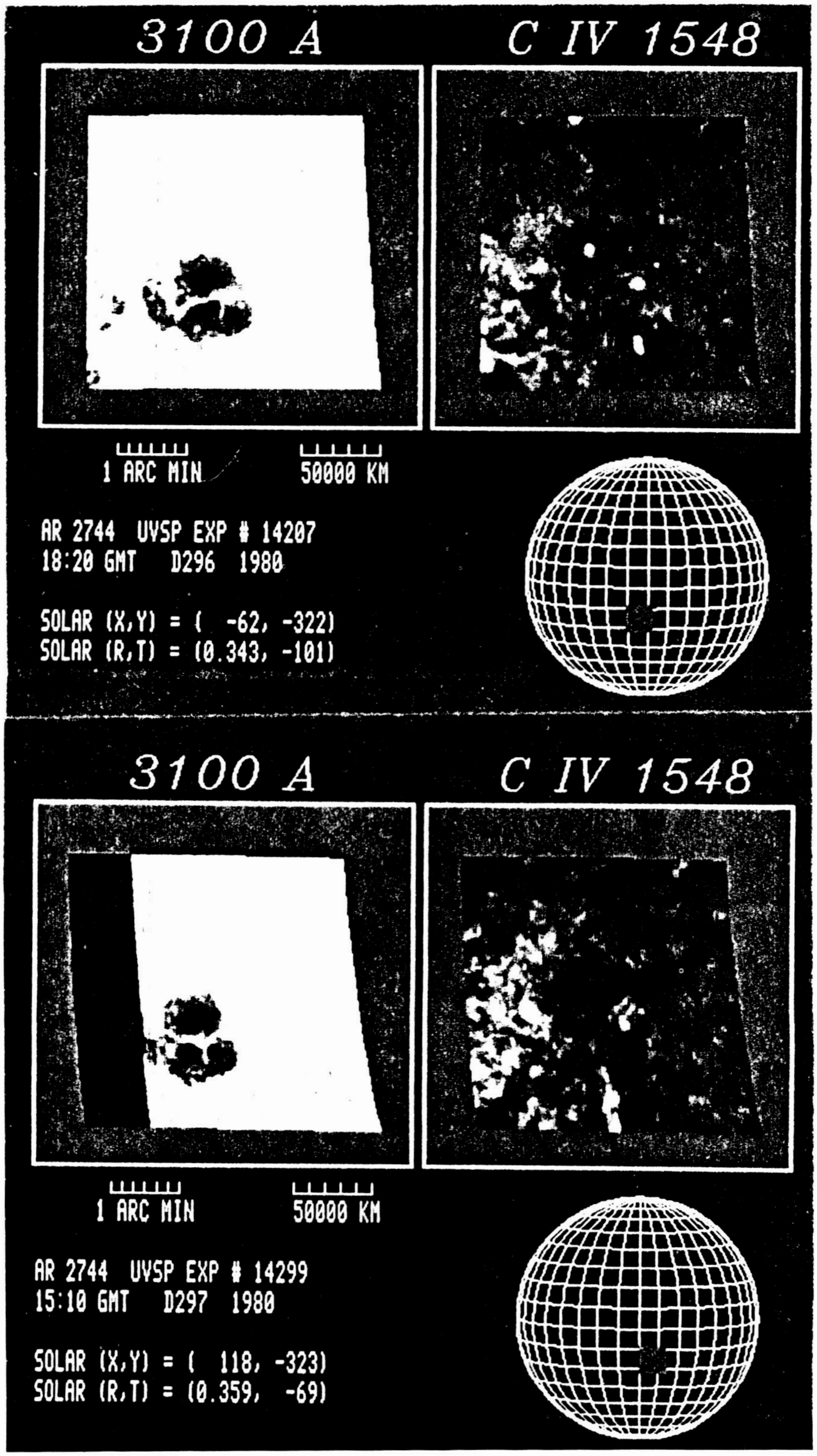

Figure 3. The 2 available long wavelength "continuum" images of the region during this time period (taken during some of the gaps in figure 1) and accompanding C IV images (taken with a different slit than the others).