Helioseismic Holography with GONG++

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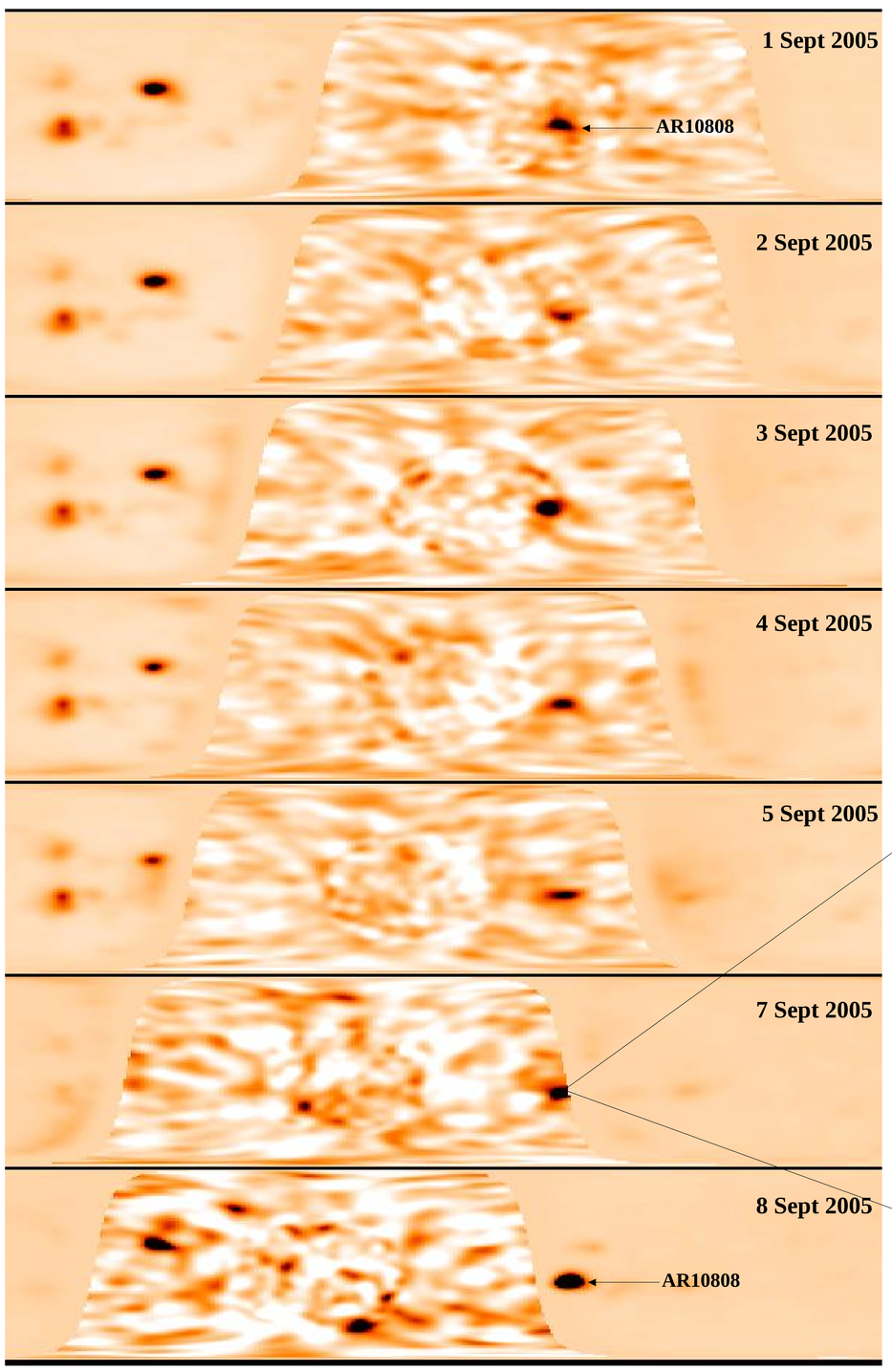
The GONG++ Program provides daily helioseismic images of the farside of the Sun online at http://gong.nso.edu/data/farside using low resolution images that are transferred from each of the sites in near-real-time. Here we show the passage of AR 10808 through the farside before it appeared on the front side on September 7 2005. We also show the first attempts to do some statistics. More than four years of GONG++ high resolution archived data give us the opportunity to create long series of maps in order to calibrate the signal into a magnetic index.

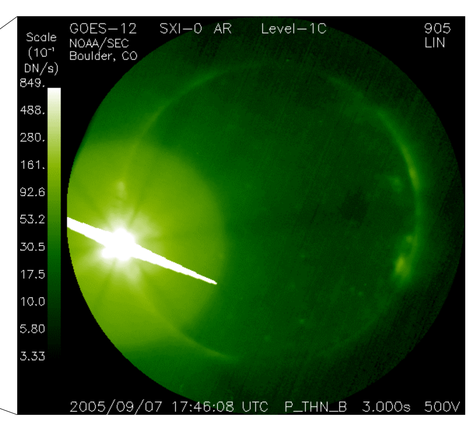
Seismic signature of AR 10808 as it crossed the farside southern solar hemisphere from 2005 September 1 to September 7 when it emerged at the east limb of the Sun and produced the fifth most intense flare on record. The maps where calculated using GONG near-real-time data. For similar results from MDI data visit http://soi.stanford.edu/data/farside)



The abscissa represents Carrington longitude. The ordinate of each image represents the sine of the solar latitude, over the range -90°(south pole)-90°(north pole). The full hemisphere images are a composite of 2x2-skip phase correlation maps, which represent the far hemisphere out to ~45° from the antipode of disk center, and 1x3-skip phase correlation maps which represent the region from ~45° to the limb.

The farside maps are overlaid on the daily GONG magnetograms that have been smeared to present a similar resolution to that of the farside maps.

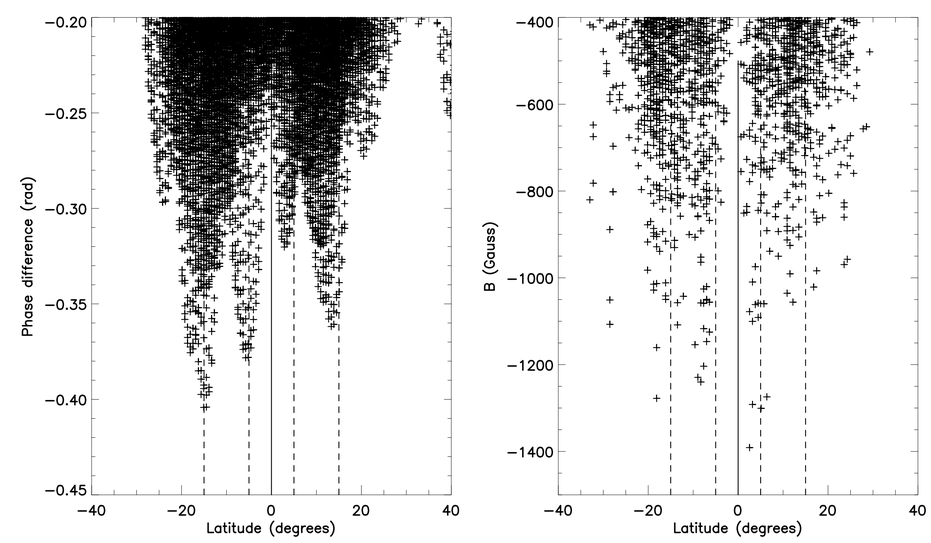
The last image of the sequence shows AR 10808 already on a front-side magnetogram.



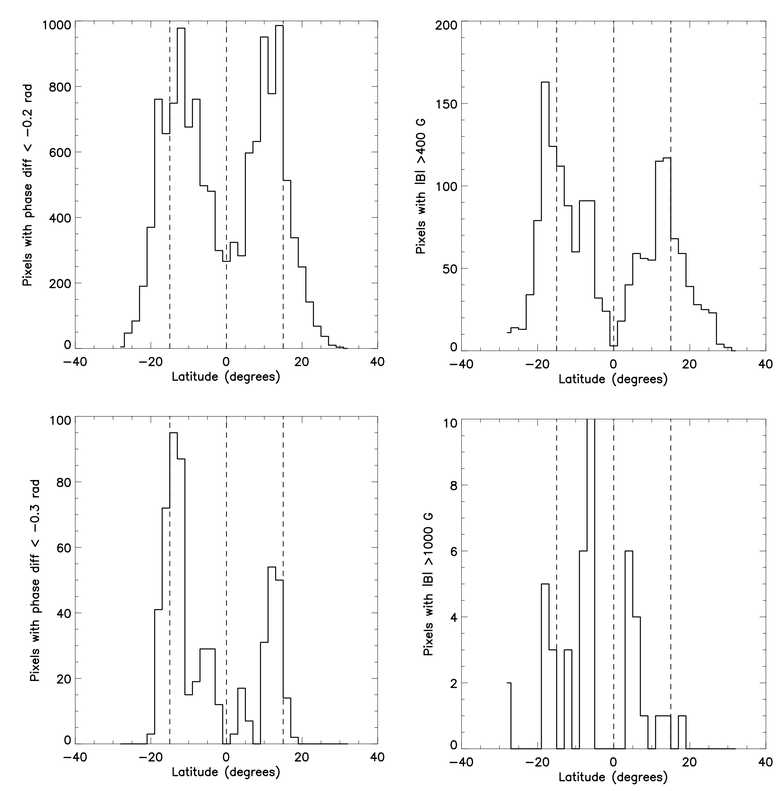
The Solar X-ray Imager onboard GOES captured the huge X-17 flare produced by AR 10808 on September 7, coinciding with the position of the sunspot as shown in the farside maps from the previous days. (Image from the Virtual Solar Observatory; cart ID: VSO-NSO-051017-068)

The HMI instrument onboard SDO will provide us with unprecedented high resolution helioseismology data of exceptional quality with full coverage to the limb. This will provide a new opportunity for helioseismic holography to produce lower-noise farside maps.

First steps towards calibrating the farside holographic signal



Phase differences calculated for the farside maps using 2.5 years of GONG++ data versus latitude (from August 2001 to December 2003, left). The crosses represent the value of each pixel versus the latitude position in the map. On the right panel, the magnetic flux of the synoptic maps (Kitt Peak) from the same period. Both panels show a greater concentration of magnetic activity in the southern hemisphere as well as major peaks surrounding the 15° latitudes. It is also noticeable that strong features appear closer to the Equator, possibly corresponding to activity at the latest phase of the solar cycle.



Histograms of phase difference (from farside maps, left) and magnetic index (Kitt Peak magnetograms, right) versus latitude. The top panel includes pixels with a wider range of phase differences and magnetic index. The bottom panels concentrate on the stronger features. The histograms in both cases confirm the presence of more magnetic activity in the southern hemisphere for this period of time. The bottom panels suggest that there was possibly a concentration of regions with high magnetic index close to the Equator.

This work utilizes data obtained by the Global Oscillation Network Group (GONG++) Program and the SOI/MDI instrument on SoHO. GONG++ is managed by the National Solar Observatory, which is operated by AURA, Inc. under a cooperative agreement with the National Science Foundation. The data were acquired by instruments operated by the Big Bear Solar Observatory, High Altitude Observatory, Learmonth Solar Observatory, Udaipur Solar Observatory, Instituto de Astrofísica de Canarias, and Cerro Tololo Interamerican Observatory. SoHO is a project of international collaboration between ESA and NASA. This work has been supported by the NASA Living with a Star – Targeted Research and Technology program.