Farside Helioseismic Holography: recent advances

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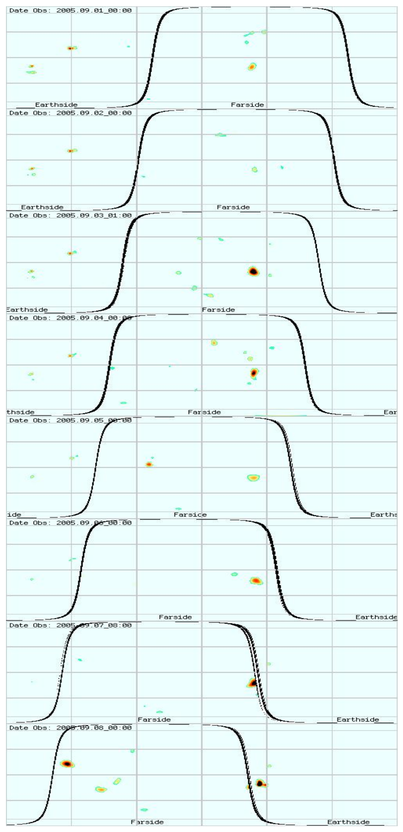
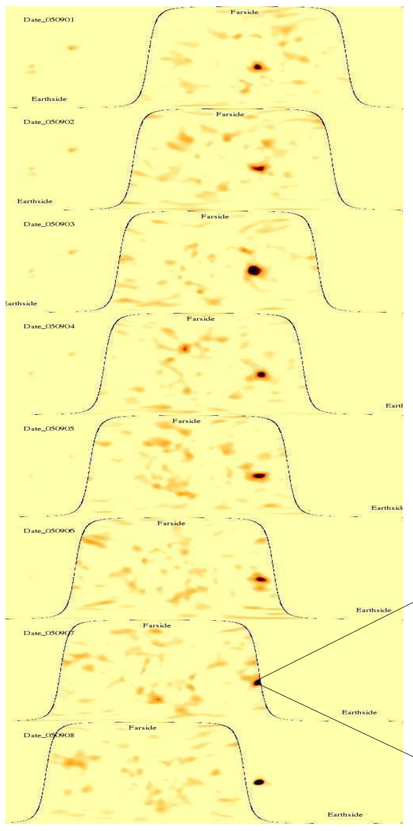
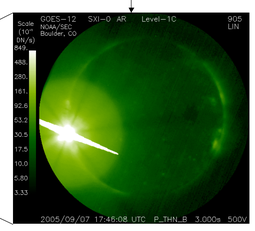
Both MDI and GONG++ Programs provide daily helioseismic images of the farside of the Sun online at http://soi.stanford.edu/data/farside and http://gong.nso.edu/data/farside using low resolution Dopplergrams taken by their instruments. Here we show the passage of AR 10808 through the farside before it appeared on the front side on September 7 2005 as seen by both instruments. We also show an example of complex CME with a farside component on September 2 2005 and the corresponding farside map at the time. Finally, we present preliminary work towards the calibration of the farside helioseismic signal.

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 one of the most intense flares on record. The maps where calculated using MDI data (left) and GONG near-real-time data (right).



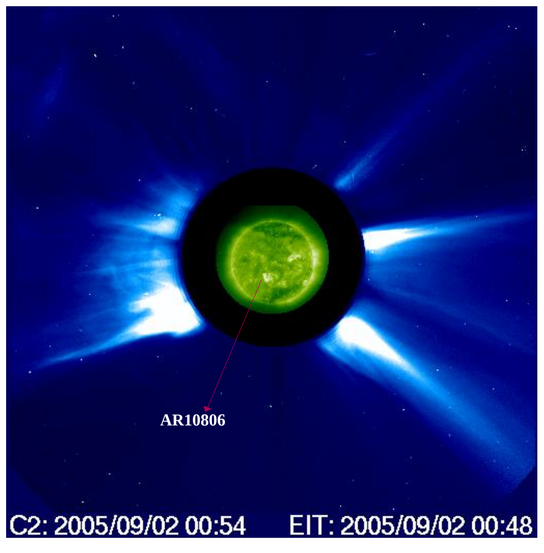


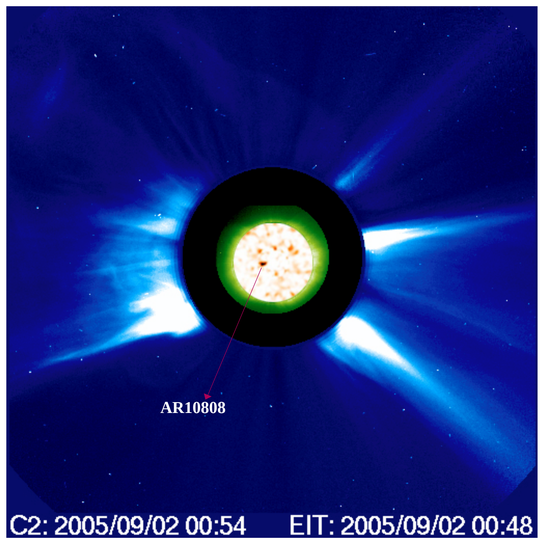
The Solar X-ray Imager onboard GOES captured the huge X-17 flare produced by AR 10808 on September 7, coinciding with the position of the sunspot as shown in the farside maps from the previous days. (Image from the Virtual Solar Observatory; cart ID: VSO-NSO-051017-068)



The 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.

Coronal mass ejection recorded by LASCO C2 coronagraph on September 2nd 2005: where did the backside component come from?

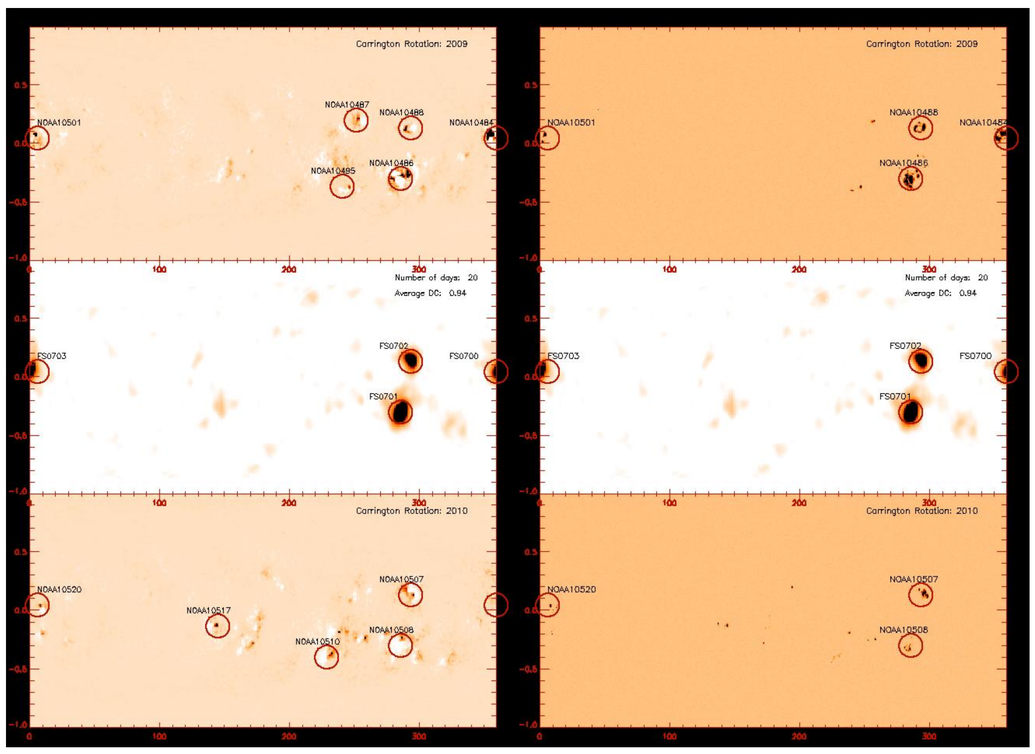




The left panel shows overlaid on the C2 LASCO image the front side of the Sun taken by the EIT instrument. The right panel shows a postel projection of the calculated farside map as seeing from Earth perspective, i.e. looking directly through the Sun.

"….By 00:24 UT, signature of a huge and apparently backsided CME can be seen all above the E Limb (most likely related to Event #2). Though the timing seem to match that of the event from AR 10806, the event off limb is most probably from the back side of the Sun. In summary, the event as a whole can be determined as an asymmetric full halo CME. Several components contribute to the overall shape of the complex event, at least one of them frontsided, associated with a B-class X-ray flare on NOAA AR 10806. However, the bigger contribution seems to have its origins on the backside" (G. Stenborg, SOHO-LASCO Operations Scientist).

First steps towards calibrating the farside holographic signal as a function of magnetic field. Analysis of farside synoptic maps and comparison with front side magnetic and intensity synoptic maps for Carrington Rotations 2009 and 2010 (Oct. 23 2003 – Dec. 12 2003)



Comparison between synoptic maps constructed from farside calculated images (center) with the previous and following Carrington Rotation front-side synoptic maps from magnetograms (left, Kitt Peak) and intensitygrams (right, MDI). Circles have been drawn surrounding the clearly identified active regions on the farside (named here FS0700,FS0701, FS0702 and FS0703 for identification purposes only) and placed on the same positions on the front-side synoptic maps. These four active regions coincide with large active regions on the front side. Not all the active regions identified on the front side however are visible in the farside maps. The analysis of particular cases will help to identify criteria in order to calibrate the farside signature as a function of magnetic field.

	Area (max)	NSpots (max)	Hale/McIntosh	Location	FS region
NOAA10484	1750	69	βγδ / Ekc	N04W29	FS5700
NOAA10486	2200	108	βγδ / Fkc	S17W63	FS5701
NOAA10487	280	23	β / Dao	N12W22	
NOAA10488	1750	61	βγδ / Fkc	N08W69	FS5702
NOAA10495	220	16	β / Dso	S22W48	
NOAA10501	410	26	βγδ / Dki	N03W32	FS5703
NOAA10515	80	9	β / Dso	S02W01	
NOAA10517	350	19	β / Dao	S08W20	

Tabulated information about the active regions identified in the above synoptic maps. The active regions highlighted in red are those clearly visible in the synoptic maps created using farside calculations. The table shows that the active regions identified by the farside processing correlate well with the larger more complex ones.

Active Region Data from www.solarmonitor.org

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.