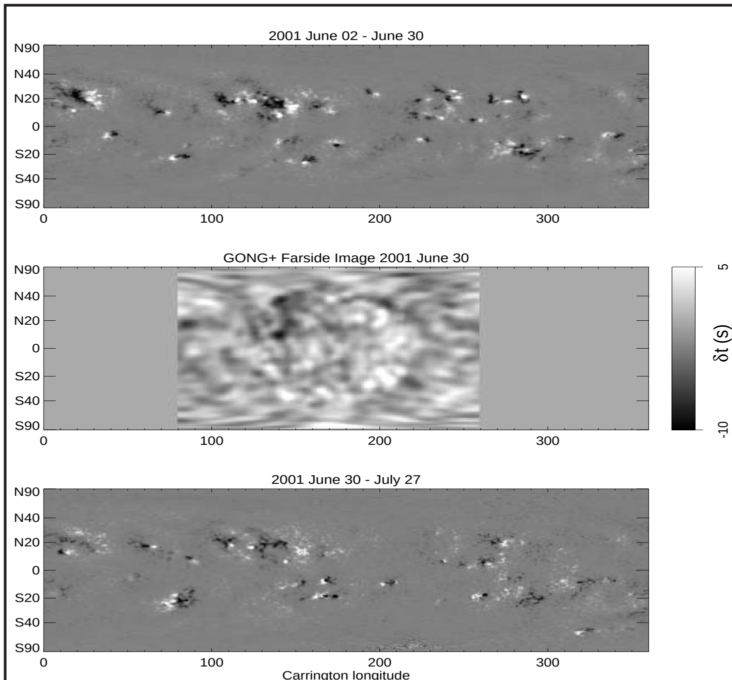
Teide Udaipur Learmonth Mauna Loa Big Bear Cerro Tololo GONG

Newsletter

Number 32 April 2002

Our last newsletter celebrated the completion of the GONG+ camera transplant, with deployments around the network. Since then, final touches were added to the Udaipur system, the turret at Mauna Loa was replaced, and Tenerife experienced some electronic problems that resulted in loss of data. The network has since settled down and performance and reliability are very good. Despite the less-than-hoped-for duty cycle during the first quarter of operation, in recent months the project has distributed over 100GB of data to the user community per month. The data bites in this newsletter demonstrate that we are beginning to get a lot out of the new and improved GONG+ data.

What we knew when we planned for the increase in the camera's spatial resolution has come true: processing full-resolution images and continuous line-of-sight magnetograms presents a formidable task for the current DMAC data reduction pipeline. We're coping by maintaining the same coverage as before, just processing $\ell < 200$, and producing the same data products. But in parallel, we have begun our next phase: GONG++, which will fully exploit the scientific potential of GONG+. The hardware has been purchased and we are designing the data handling system, which will focus on high-ℓ global *p*-mode processing and local helioseismology methods. Implementation of the system will continue through FY03.



The first far-side image of the Sun obtained from the GONG+ network. It was computed by Douglas Braun (NorthWest Research Associates) using 19 hours of data on 2001 June 30 and obtained from the GONG+ sites at Cerro Tololo, Big Bear, and Learmonth. The seismic image in the center shows acoustic travel-time perturbations over the entire far hemisphere of the Sun and was obtained using helioseismic holography as described by Braun and Lindsey (2001, *Astrophys. J.* **56**, L189). The panels on the top and bottom show synoptic magnetograms for the preceding and following solar rotations. The largest active region in the preceding rotation (at 140° longitude) shows up distinctly while it was on the far side (although with an unusual shape). See http://www.colorado-research.com/~dbraun for more information on farside imaging and helioseismic holography.

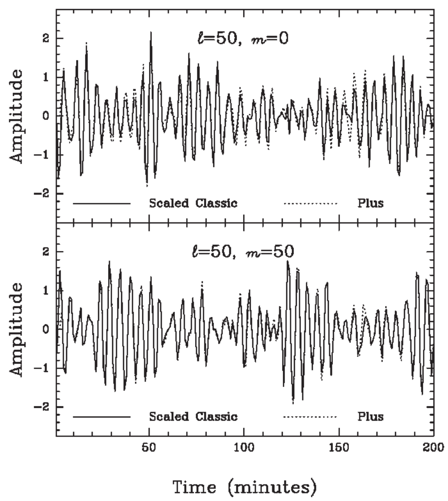
The Project has had some comings and goings, suffering the loss of an important member of the team and enjoying the addition of several new folks. Lana Britanik stayed with the project until the deployment was complete and the real-time instrument control was handed off. Thanks Lana! Chirag Shroff stepped into Lana's shoes and is getting comfortable with the real-time software challenge. Richard Clark is supporting the instrument science and data analysis group, and Thierry Corbard has taken on GONG++ local helioseismology science pipeline development.

See you at Big Bear!

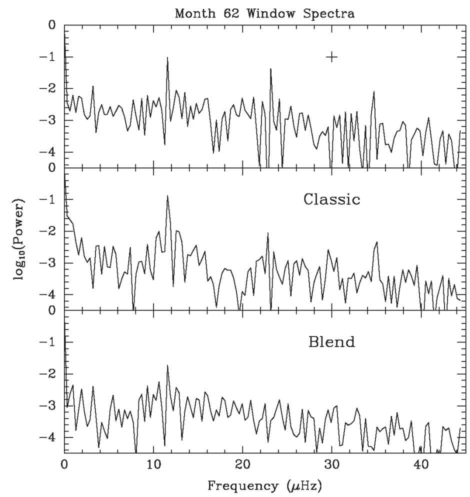
Meeting Announcement

GONG 2002-SOHO 12 will be held at the Big Bear Solar Observatory 27 October – 1 November 2002. Check www.bbso.njit.edu/gong02 for details.

GONG Classic to GONG+ Transition



Comparison of a short segment of the ℓ=50, *m*=0 and ℓ=50, *m*=50 time series from GONG+ and the scaled version of GONG Classic. The phase and amplitude of the two time series agree quite well.

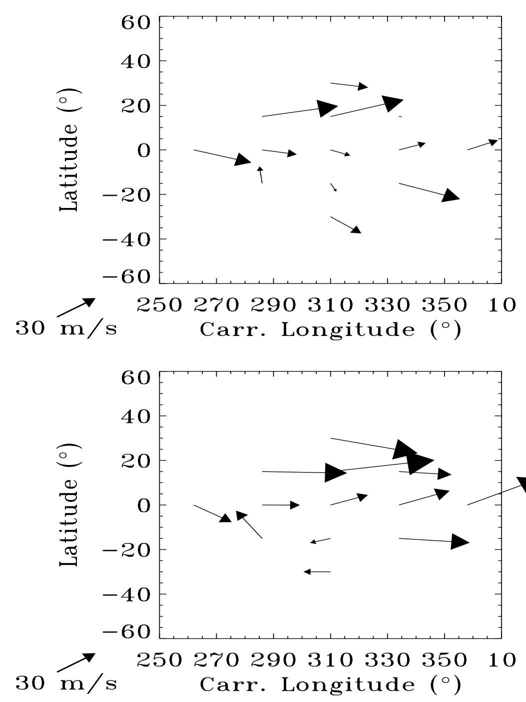


Month 62 temporal window spectra for GONG+ (top), GONG Classic (center), and the "Blend" of Classic and + (bottom). Note that the Blend produces a much cleaner window spectrum, with substantially reduced 1/day sidelobes.

GONG++ Development

By the end of 2002, the project will have completed a major computer hardware upgrade to support GONG++ activities. This upgrade supplies the project with the equipment needed to develop and later to routinely operate local helioseismology applications that will exploit the higher spatial resolution provided by the recently upgraded GONG+ cameras. To date, the equipment has included replacing most of the project's workstations (including the last of the vintage Sparc2s and Sparc20s) with 900 MHz SUNBlade 1000s. In addition, the project purchased its first server, a SUNfire4800 (12/750MHz cpus), with 24GB of RAM, 3TB of disk, and a small automated tape library. A larger automated tape library is slated for year-end purchase.

The software functional and performance requirements have been refined, and in February the project conducted a conceptual design review to help shake-out the software strategy for the GONG++ data handling system. An overview of the data reduction pipeline infrastructure and the major processing modules were defined and trade studies for the cache and archive were proposed. The data processing pipeline system developed and used by the Space Telescope Science Institute for processing all Hubble Telescope data (OPUS) was selected as the support for the GONG++ pipeline architecture and we are proceeding with its implementation.



Deborah Haber [Colorado] and Rick Bogart [Stanford] have produced the first comparison of the direction and magnitude of subsurface flows at selected depths inferred from ring diagram analysis of 11 hours of data from MDI (above) and the GONG+ Big Bear instrument (below). Independent analyses were performed for a set of thirteen 15° regions centered at the Carrington coordinates of the bases of the arrows representing the flows. These results are from 1-Dimension RLS inversions at a depth of 7.1 Mm. The results have shown excellent agreement in the flow maps at depths below 2 Mm, but discrepancies near the surface. These variations are currently thought to arise from the differing optical distortions in the two instruments, which mostly affect the high-ℓ modes that sample just below the surface.

What Data Can I Get from GONG?

GONG data is freely available on the www or by contacting the Project.

Some of the currently available products for the helioseismologist are:

Power spectra of solar oscillations covering the range of $0 \le \ell \le 200$, $-\ell \le m \le +\ell$, and $0 \le \nu \le 8.33$ mHz.

Time series of complex spherical harmonic coefficients as a function of ℓ and m in the range $0 \le \ell \le 200$ and $0 \le |m| \le \ell$.

Estimated frequencies, amplitudes, and linewidths of solar oscillation modes, as a function of ℓ, m, and ν covering the range $0 \le \ell \le 150$, $-\ell \le m \le +\ell$, and $1.2 \le \nu \le 4.0$ mHz.

Both the time series and power spectra are available for temporal intervals of GONG months (GM), with 1 GM ≡ 36 days. Note, however, that the mode parameters are computed from overlapping three-GM (108 day) temporal intervals, with a one-GM spacing. Time series and power spectra are also available for $0 \le \ell \le 45$ for intervals of 1 GONG Year (10 GM or 360 days) and 35 GM. All data from 7 May 1995 to 10 May 2001 have been processed to time series and power spectra, and the mode parameters have been computed on all possible intervals of 3 GM.

For the non-helioseismologist, we have:

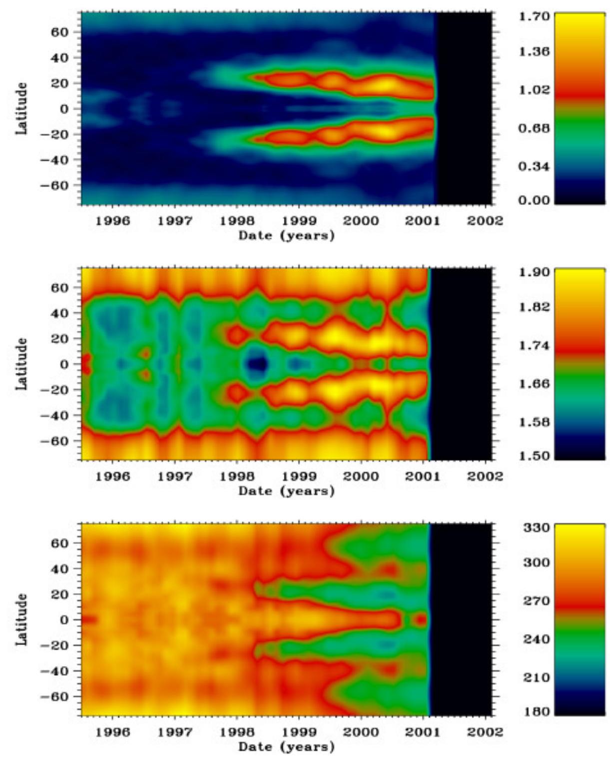
- *Minute-by-minute images of the solar surface Doppler velocity field from 7 May 1995 to the present.*
- *Magnetograms every 20 minutes, plus derived synoptic maps for Carrington rotation cycles 1896 through 1942; and*
- *Low-pass, temporally filtered, and geometrically registered images of the surface Doppler velocity with a cadence of 4 minutes and a filter width of 17 minutes, useful for studies of slowly evolving flows from 7 May 1995 to 17 October 1998.*

Finally, we have implemented a new data service that provides near-real-time magnetograms with rough calibration and a cadence of about one every two hours around the clock. They can now be obtained at:

ftp://www.gong.noao.edu/pub/gong/magnetograms

Mode Parameter Variations

Mode frequency (top), mode width (middle) and mode energy (bottom) show a marked solar-cycle variation. In the GONG analysis, the parameters are evaluated separately for each (ℓ,m,n) mode. This allows us to use the m-dependence of the results to study latitudinal effects. Here, the changes for modes with $40 \le \ell < 80$ and $9 \le n \le 11$ have been localized in latitude using an Optimally Localized Averages technique. The units are microhertz, microhertz, and 10^{30} erg, respectively. The increased frequency, increased linewidth and decreased energy of the modes correspond to the spatial distribution of magnetic flux.



Multitaper Reprocessing of PEAKFIND

The multitaper peak fitting has now been used to reprocess all 59 108-day time series obtained during the operation of GONG in “classic” mode. The multitaper method helps to improve the fitting of mode parameters by producing smoothed power spectra, which leads to an increase of the number of modes per multiplet that are fitted well and thus to an increase of the order of 10% in the number of multiplets for all time samples. This improvement is expected to lead to improved inversion of properties of the solar interior.

Site Focus ... Teide

The Observatorio del Teide (on the island of Tenerife, Canary Islands, Spain), together with the Observatorio del Roque de los Muchachos (on the island of La Palma), plus the scientific headquarters and technical installations of the Instituto de Astrofísica de Canarias in La Laguna (Tenerife), form the European Northern Observatory (ENO, http://www.iac.es/eno). Situated at 2,400 meters above sea level, longitude 16º30’35" W and latitude 28º18’00" N, and with a surface area of 50 hectares, the observatory possesses the quality of the Canarian skies for observational astronomy that has been recognized since the end of nineteenth century. The cold ocean currents surrounding the Canary Islands in combination with the trade winds provide a unique stable climate with little atmospheric turbulence. It is also noted that the inversion layer, where low altitude clouds form, generally remains well below the mountain peaks and has the added advantage of blocking artificial light sources from populated areas.

In 1968, a collaboration was established among a number of European institutes to establish an optimal site for solar observations. An extensive site testing campaign, comparing over 40 prospective sites, identified La Palma and Tenerife as the best observing sites. The astronomical quality of the Canarian Observatories is guaranteed under a specific law approved in 1988 (known as the "Ley del cielo"). This makes the IAC's Observatories a legally protected site (in effect an astronomical "reserve") where continued dark skies, low radio frequency fields, and control over other sky-polluting effects – including aircraft flight paths – are guaranteed.

In addition to night time telescopes and experiments, three solar telescopes are placed at the observatory: the 45 cm GCT (Gregorian Coudé Telescope, University of Göttingen), the 60 cm aperture and 18 m long vertical spectrograph VTT (Vacuum Tower Telescope, Kiepenheuer Institute of Solar Physics), and 90 cm THEMIS (Franco-Italian Heliographic Telescope for the Study of Solar Magnetism) the most advanced solar telescope in the world at present. The IAC’s solar laboratory, a building in the form of a pyramid aligned north-south, constitutes an important symbol of a long tradition in the observations of solar oscillations, being the host of the largest concentration of helioseismology experiments in the world: GONG, IRIS (University of Nice, France), BiSON (Birmingham University, UK), TON (University of Taiwan, Taiwan) and ECHO (High Altitude Observatory, USA).

GONG’s web site http://www.gong.noao.edu is up-to-date with Project status, scientific investigations and publications, access to data products, and links to other activities within the field of helioseismology.

For *FTP* archives: ftp://www.gong.noao.edu/pub/gong.

The GONG Newsletter is also available on GONG’s web site as a WWW document and an easily printable PDF document. We encourage you to avail yourself of this service.

You can be removed from the hardcopy mailing list, and added to the e-mail notification list, by simply sending an e-mail message to gong@noao.edu.

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