

GLOBAL OSCILLATION NETWORK GROUP

EL TEIDE • UDAIPUR • LEARMONTH • MAUNA LOA • BIG BEAR • CERRO TOLOLO

GONG

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GONG continues to stretch and grow with the new science applications for local helioseismology applications (see figures 1 and 2), and is looking forward to global analysis out to spherical harmonic degrees (ℓ) of 1000. At the same time, we are working hard to maintain ailing components and systems. But the good far outweighs the bad and GONG's future is very bright. GONG's new status as a Flagship Program of the National Solar Observatory (NSO) is highlighted below.

Simon Kras left the program in August to return to graduate school. Simon brought more than a good work ethic and bright mind to GONG, he was very actively involved in the Employee's Association and started NOAO/NSO's continuing involvement in the Habitat for Humanity program. Best of success, Simon... and look us up when you're ready for a postdoc. Caroline Barban left in October for Leuven, Belgium, and we look forward to continuing work on the velocity-intensity correlations.

As a quick reminder, next year's meeting, GONG 2004/SoHO 14, is being organized by Yale University and will be held 12–16 July 2004 in New Haven, CT. For more information, contact Sarbani Basu at sogo04@astro.yale.edu.

Paradigm Changes: Project to Program

During the last year, GONG has been in the process of restructuring its management plan from its original status of a limited-term project to a cornerstone program of the NSO. Coupled with this paradigm change has been the mandate from GONG's Scientific Advisory Committee and the AURA Solar Observatory Council to increase in-house science. The task at hand has been to rethink the decisions that were made in designing and developing an instrument and data processing system for a three-year run, and to find the means of transforming it into a system optimized to run continuously, as well as more efficiently and at reduced costs. The program's primary challenges for this transition have been addressing instrument maintenance and reengineering issues, and streamlining the data processing. We have identified a number of design choices, such as the "sneaker net" for transferring data between data reduction stages, and deferred items, such as turret covers, that were of low priority in the context of a three-year project. We have identified major long-period recurring items as well, such as data archive migration and the need for a replacement shelter. The list is long.

In an effort to address limited-lifetime-model issues, and to establish a program of continuous renewal, George Luis was hired to reestablish the prototype instrument at the GONG farm as a true ground simulator to examine reengineering options and plan the replacement shelter. Due mainly to aging components, failures in

the field have resulted in the prototype instrument being stripped to provide spares for actual field systems. As a result, it is no longer available as an engineering site for testing and certification of fixes and modifications and as a test bed for the development of replacement technologies. The instrument shelters, modified 20-foot shipping containers, were expected to have a worst-case 11-year lifetime, and the worst case was always recognized to be

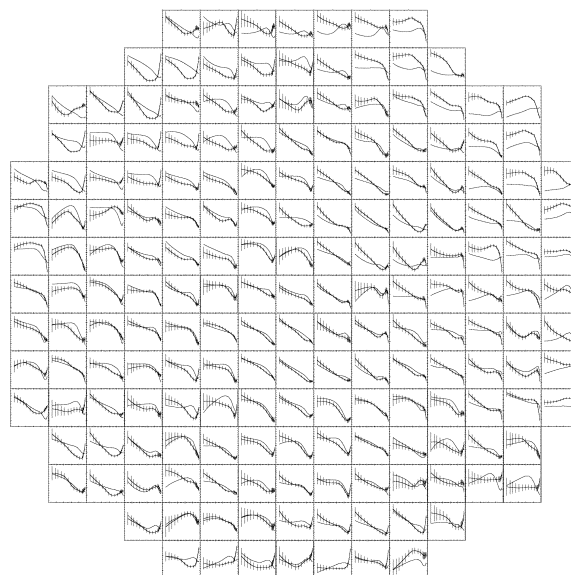


Figure 1. Preliminary comparisons of GONG and SoHO/MDI local helioseismology using ring diagrams. The variation of the zonal (east/west) flows with depth are shown. A total of 189 patches covering the surface of the Sun were compared down to a depth of $0.1 R_{\odot}$. GONG data are dark lines with error bars, MDI data are gray lines. These data are in excellent agreement for this first analysis by Irene Gonzalez-Hernandez.

Learmonth, due to its location on a dune a few hundred meters from salt water. The poor condition of the Learmonth shelter has been recognized for some time, and indeed all of the shelters are subject to various levels of environmental and usage deterioration. A plan to build a spare shelter is now being developed, with a design and construction review anticipated in the spring. The Tucson/Learmonth shelter swap would occur in 2007.

Similar restructuring and rethinking are taking place with the data processing and management. The original data-reduction "pipeline" consisted of a fairly labor-intensive "sneaker net," where serial

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processes were assigned to specific workstations and data were passed from machine to machine by human operators carrying removable media. The dependence on human labor broadly occurred at two levels: moving the data from process to process, and carefully inspecting intermediate data products for anomalies before advancing to the next process. Over the past year, we have made considerable progress in transitioning to process-controlled pipelines, which has substantially automated the data transfer and reduced the labor requirement. Automated image quality assessment software is in the final testing stages and should result in an even larger reduction in the hands-on quality assurance.

In addition to achieving and sustaining a steady-state operation, an out-year plan that addresses limited-life issues and continuous renewal and improvement is being put into place. This baseline plan will then be the platform upon which the development of new science and technical capabilities can be undertaken.

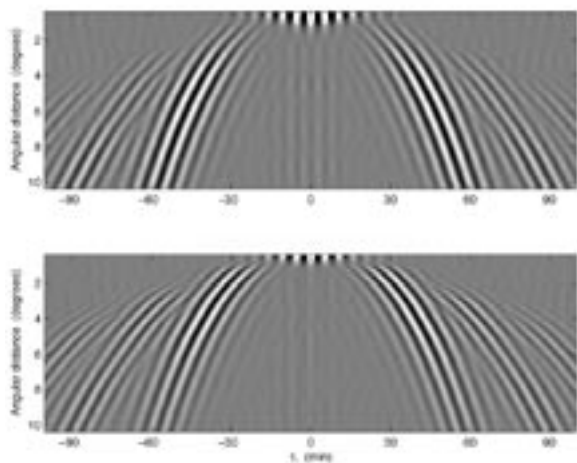


Figure 2. Preliminary comparisons by Shukur Kholikov of GONG (above) and SoHO/MDI (below) local helioseismology using time-distance. The fundamental data for “time distance” helioseismology is the delay between the signal at an origin and points at progressively greater angular separations (Δ degrees), as measured by their cross-correlation. Again, the agreement is excellent.

As mentioned earlier, the push for more in-house science is a major component of the restructuring process. The “sneaker net to controlled pipeline” transition has already led to the reprogramming of one position from data reduction to science, and we should add another scientist next year. The helioseismology community continues to be actively involved, with a renewed interest in short-term visits and in collaborative efforts such as the Local Helioseismology Comparison Group (LoHCo), which consists of over 30

members. From a science and management perspective, life in GONG is good and getting better!

Site and Instrument Operations

Operations activities for the months of July and August were focused on training activities for one of the site personnel. Sudhir Gupta from the Udaipur Solar Observatory visited Tucson for five weeks to become familiar with routine maintenance tasks and instrument troubleshooting procedures. Since Udaipur is the site most difficult to support, in terms of access by GONG personnel and shipment of replacement parts, having someone at the site with a greater depth of knowledge seemed beneficial for keeping the instrument operational. Sudhir was willing and able to assist us in that regard. During these months the monsoon was active in Udaipur, and the instrument there was shut down and the turret covered.

In preparation for Sudhir’s visit, considerable effort was spent updating GONG documentation and procedures and creating a training manual. His training began with replacing the turret at the Tucson instrument along with a complete optical alignment. He became thoroughly familiar with camera removal and installation as he experienced some of the things that can and will go wrong. Sudhir’s time with us was well spent and he now will be an even greater asset to GONG operations back in Udaipur. Before leaving, Sudhir was awarded the first certificate of recognition as a “Certified GONG Repair Person.”

A preventive maintenance trip to Mauna Loa took place at the end of September. Other than replacing the CCD camera, only routine maintenance tasks were planned. The turret inspection, however, revealed that at least a couple of tablespoons of water had penetrated the environmental seals. As much water as possible was removed, and since the instrument was running well in spite of this, nothing more was done. It became clear, however, that the turret should be replaced and the problem corrected. This discovery does raise a larger issue. Why aren’t the recently rebuilt turrets weatherproof? The turret at Mauna Loa has been in place for only 20 months and a turret installed at Learmonth was in place only about six months before failing. We are currently investigating the procedures used in refurbishing a turret and implementing tests, which will establish the effectiveness of the seals.

A large advance was made in eliminating noise in the velocity data seen at three of the network sites. Troubleshooting showed that the camera rotator was introducing noise in the temperature stabilizing electronics for the oven containing the Lyot filter and Michelson interferometer. This small temperature fluctuation produced a somewhat periodic velocity signal, which was fortunately of such a low frequency

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that there was no significant impact on the oscillation data. Isolating the oven from the camera rotator by removing a ground strap from the oven chassis solved the problem.

Data Processing, Analysis, and Management

Testing has continued on the GONG local helioseismology pipeline. A run of early data (July 2001) through the ring diagram pipeline revealed days with the so-called “washing machine” effect, where the Sun is apparently spinning around disk center. Since we have reason to believe that the Sun is actually not behaving in this manner, we are investigating. It is suspected that the underlying problem is a temporally varying error in the alignment of the images with solar North. Cliff Toner is working on the problem, which currently has several potential solutions: the use of legacy MDI data as a fiducial, the initiation of more frequent drift scans at the sites, and the inclusion of camera rotator errors measured with the Ronchi grating in the instrument. In addition, Cliff is analyzing the recent Mercury transit data to develop an improved atmospheric refraction correction for the drift-scan analysis.

Rudi Komm has been supporting LoHCo. This group has had three recent get-togethers: a face-to face meeting in Boulder, CO, on July 28; and two teleconferences on August 14 and October 2. Doug Braun, Charlie Lindsey, and Martin Woodward at Colorado Research Associates very graciously and successfully hosted the Boulder workshop. The workshop materials can be found on the LoHCo Web page (gong.nso.edu/lohco). The recent focus of this group has been on artificial data exercises. Rachel Howe has been constructing artificial three-dimensional power spectra based on a model of ring diagrams, and generating wave fields from the spectra. Irene Gonzalez-Hernandez and Shukur Kholikov have been taking these spectra and wave fields and analyzing them with ring diagram and time-distance techniques. They have been finding that the local analysis methods do a reasonable, but not completely accurate, job of recovering the input velocity fields. Work is underway to improve the artificial data since approximations in its generation may

impact the results. Shukur has also continued work on the installation of Tom Duvall's time-distance code in the GONG local helioseismology pipeline.

In addition to the LoHCo community support, Rudi and Rachel have been pursuing scientific goals. Rudi is finishing up a study of the fluid dynamics of the convection zone as inferred from ring diagrams, and Rachel is working on localized mode parameter changes and a model of the global flow field. Caroline Barban has performed her V-I fitting method on a set of MDI data and compared it with GONG data from the same time period. She has found a rather different frequency dependence of phase shifts between V and I as observed by the two experiments. As mentioned earlier, Caroline left us for a position in Belgium at the end of October. She will be sorely missed.

Richard Clark continues to work on the automated rejection of bad images. He is running his method in parallel with the visual inspection done by Greg Ladd. Richard will soon have a GONG month of data processed through to global inversions to compare with the traditional handcrafted method. Katrina Gressett is working on producing a one-week-long power spectrum up to $\ell \approx 1200$. This data will be provided to the community for use in developing ridge-fitting techniques. Jean Goodrich is working on aspects of the near-real-time processing at the sites that will feed the farside pipeline.

We have enjoyed short-term visits from Anna Malanushenko, Thierry Corbard, and Paul Rajaguru. Anna is an undergraduate at Saint-Petersburg State University, and she has finished the installation and testing of the farside imaging code developed by Charlie Lindsey and Doug Braun. Thierry returned in October from the Observatoire de la Côte d'Azur for a month-long visit and is improving the ring parameter inversion code. Paul is installing the time distance code he is developing Mike Thompson at Imperial College (London) in the GONG local helioseismology pipeline.