GONG

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Over the last two years we have kept you up to date with our step-by-step progress in building and implementing the GONG++ data handling system. Following an exhaustive design phase, we started with hardware purchases; installed the Space Telescope Science Institute (STScI) pipeline software package, OPUS; and implemented the ring-diagram pipeline, which is the first application in a suite of local helioseismology methods that will be the heart of the new automated processing environment. Though we have just begun applying the full system, the investment is already paying off!

At the joint GONG/SoHO meeting last October, local helioseismology methods and analyses were hot topics, and it was at that meeting that a group was formed to establish consistency between the different methods and data sources. A mere few months later, on March 17–19, GONG hosted the first Local Helioseismology Comparisons (LoHCo) Group workshop. The researchers—representing Stanford University; University of Colorado; University of Southern California; Yale University; Imperial College London, UK; Observatoire de la Côte d'Azur; Northwest Research Corporation; and NSO—are conducting a comparison of local methods in order to understand the systematic errors arising from the data processing choices and from the different data sets. There are currently three major methods: acoustic holography (AH), time-distance (TD), and ring diagrams (RD), and three data sets are being used in the comparison: MDI, GONG+, and Mt. Wilson (see "Data Management and Analysis" below). The LoHCo group has an aggressive program to advance this new area of solar physics, which can be seen in its entirity on the GONG Web site.

Operations

The year began with a light-feed replacement at Learmonth. The instrument initially went down because of damage to the waveplate amplifier. However, after a thorough checkout of the system did not clearly reveal the cause, the instrument was powered up again only to suffer another failure. A two-person team traveled there to troubleshoot the problem first-hand. Their diagnosis pointed to a short in the turret pitch motor—the third occurrence of this kind of problem in a year and the second occurrence at Learmonth. A replacement turret was shipped to Learmonth and a third person was sent down (taking the place of one returning) to perform the optical alignment. Work continued in spite of considerable delays in the arrival of a complete set of alignment tools, and on February 8 the instrument was again fully operational. Many thanks to the on-site staff who devoted considerable time away from their own work to help understand the problem, as well as to those GONGsters who stepped up on short notice to undertake an extended trip to Learmonth.

While at Learmonth, the team also replaced the camera rotator. Current thinking is that the noise from the rotator motor was being picked up by the oven heater circuit, disturbing the oven temperature stability and causing anomalous velocity signals. The new rotator significantly decreased the problem, but the suspect rotator has not reproduced the problem at the Tucson engineering site. Perhaps it's a combination of rotator motor noise and a yet undiscovered mechanism that makes the oven susceptible to the noise. We will keep you posted.

On February 22, there was a magnitude 5.4 earthquake centered only several kilometers from the Big Bear Solar Observatory. Early reports from the local staff indicated that the instrument had become misaligned, but that no other damage was apparent. Due to bad weather, a team was unable to inspect and realign the instrument until a week later. The misalignment was then corrected, and closer inspection did not reveal any additional damage. Once on site, the team took the opportunity to perform a few routine maintenance tasks, and the instrument was back in operation on March 5.

Problems with the electrical power at the El Teide site revealed flaws in two of the instrument components. The Uninterruptible Power Supply (UPS) system, which switches the system to battery power once a power interruption is detected, is not cleanly switching power. As a result, the data computer CPU lost the contents of its BBRAM during one of the short power interruptions. The spare CPU board was installed and the memory now stays intact through a power glitch. Why the UPS is not really uninterruptible will be investigated during a preventive maintenance trip scheduled for June.

The Udaipur Solar Observatory suffered extended power failures during the second half of February. The backup diesel generator took over, but extended usage required it to be shut down until some minor maintenance could be performed. Because many of the local staff were away from the observatory at the time, and because the utility power to the observatory could not be restored immediately, the site was down for 10 days, resuming operations on March 1.

Data Management and Analysis

During the past quarter, the DMAC produced month-long (36-day) velocity time series and power spectra for GONG+ months 73 and 74 (ending 21 August 2002), with fill factors of 0.77 and 0.86 respectively. The Data Storage and Distribution System (DSDS) distributed 350 gigabytes in response to 33 data requests. In the previous two quarters, the DSDS distributed 333 and 360 gigabytes, respectively.

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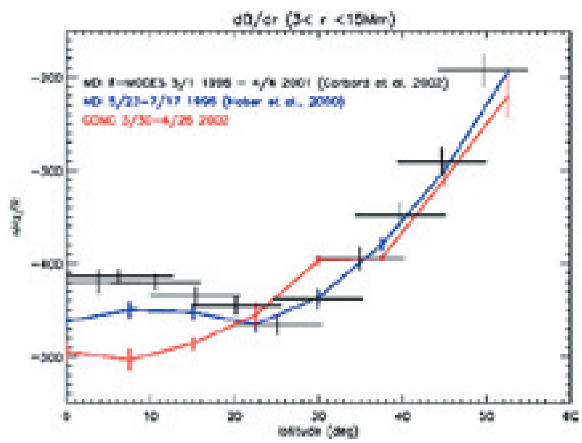
Upgrades to the DSDS data access facility will proceed in parallel with the GONG++ pipeline implementation. Once the GONG++ pipeline and its storage facility is fully established, transfers of GONG data products to external users will be expedited substantially.

Because some of the folks who attended the LoHCo workshop also hold seats on GONG's Data User's Committee (DUC), a DUC one-day overlap meeting was scheduled. DUC Members Sarbani Basu, Ed Rhodes, and Jesper Schou were present, Charlie Lindsey sat in for member Doug Braun, and Sylvain Korzennik participated via telcon. Since the last Tucson DUC meeting was in 1999, it was a nice opportunity for committee members to reacquaint themselves with GONG staff members, and to see the new gongxx server system in operation. Pat Eliason, who stepped into Jim Pintar's shoes, discussed the paradigm shifts that are bundled in the transformation from a three-year project to a long-term program. The main changes affecting the DMAC have to do with an open-data policy, re-engineering efforts to automate the reduction pipeline processing, and the newly implemented GONG++ pipeline system. General issues, such as network performance, updating the documentation, saving the 8 millimeter archive, and redesigning the GONG+ pipeline, were discussed, as well as such science-related processing issues as image distortion, magnetogram calibration, mode frequency identification and the spatial leakage matrix, and V-I fitting. Reducing the backlog loomed large on their list of things to remedy. The next meeting is scheduled for August.

The ring-diagram portion of the GONG++ pipeline is essentially ready. Rudi Komm and Thierry Corbard (who is working long-distance from his new home in Nice) have installed code to produce synoptic charts from the dense-pack maps. The synoptic charts can be analyzed to yield basic fluid dynamics quantities, such as divergence and vorticity, which show interesting features, including the divergence at the equator and opposite signs of vorticity across the equator. Rachel Howe has been looking at the relationship between the surface magnetic field and localized shifts in frequency, width, and amplitude, and has found close agreement between the spatial distributions of all of these quantities.

The next major steps in the development of the GONG++ pipeline system are the installation of the Veritas™ Storage Migrator software, which will enable the LTO library, the implementation of a graphical user interface (GUI) for the ring-diagram production pipeline, and the installation of the time-distance and acoustic holography methods. The community has contributed these packages to the project: Tom Duvall has installed his time-distance code, and Charlie Lindsey and Doug Braun are doing likewise for holography. Many thanks to them for these very generous contributions! Given the huge volumes of data, it is much more effective to install the programs than transport the data.

As mentioned earlier, GONG hosted the first LoHCo Group workshop on March 17–19. Chaired by Rudi Komm, the LoHCo group comprises about 20 researchers who are performing a series of tests and comparisons to verify local helioseismology methods. The first workshop included a number of presentations that highlighted state-of-the-art processing and analyses and used simultaneous sets of MDI and merged GONG+ images for the initial tests. These preliminary results showed overall general agreement between three different ring-diagram pipelines applied to both data sets, and for the time-distance analysis, which was applied to the two data sets. These tests will be expanded to holography, and will culminate in the crucial comparison of applying all three methods to the same data set. The LoHCo Group Workshop report can be found at *gong.nso.edu/workshop*.



Surface radial shear as a function of latitude from MDI f-modes and GONG/MDI ring diagram analysis (image courtesy of Thierry Corbard).

Caroline Barban has applied the V-I multispectral fitting method to several hundred modes up to degree 50. She has produced measurements of the usual parameters (frequency, amplitude, line width) as well as several new ones that include various noise components and phase differences. Caroline is busy working on the physical interpretation of these results.

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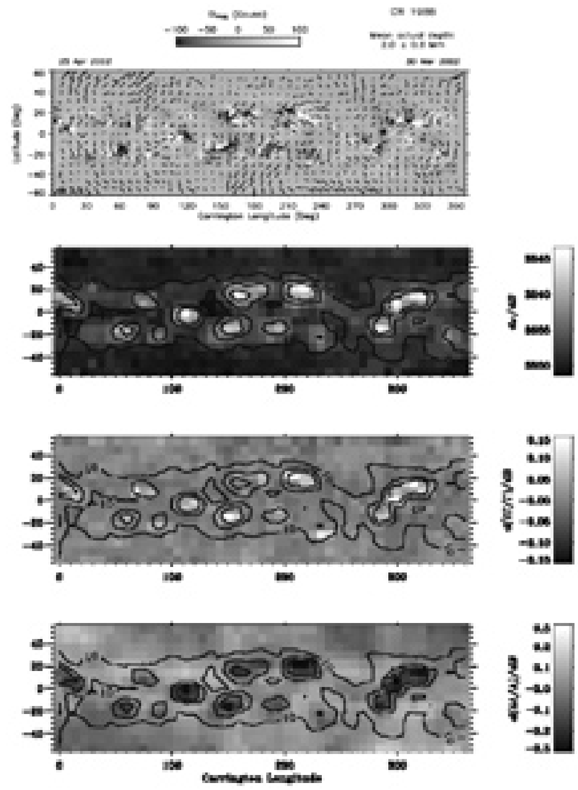
Richard Clark continues to work with Jack Harvey on the correction of the GONG+ magnetogram zero point. The current approach is to use the magnetogram calibration images at a single site to first produce the "best" magnetogram of the day, which is then used to correct the rest of the images at that site. They have found that temporal variations in the "best" magnetogram can be reduced by averaging magnetograms from a few adjacent days, and are working hard to push the zero-point uncertainty below 1 gauss.

The zonal components of the first GONG+ synoptic flow map (Carrington Rotation 1988) were averaged over longitude and symmetrized over latitude in order to compare with the previous results obtained using MDI f-modes splittings. The overall agreement between these curves confirms the two principal features of the radial shear between 3 and 15 megameters below the photosphere: (1) an outward decreasing angular velocity with a slope of 400 to 500 nanohertz per solar radius that persists up to about 40° and that (2) decreases rapidly at higher latitudes.

The gradient is about half that expected from angular momentum conservation and indicates that processes such as diffusion are probably operating in this zone that produce an exchange of angular momentum between parcels. These results were obtained by spatially degrading the potential of local helioseismology in order to compare with global helioseismology, but give us an important confidence in the new analysis, and especially the depth dependence of the inferred flows.



Four types of spatially resolved synoptic maps of solar properties inferred from GONG+ data obtained in April 2002. From the top, the first frame shows the horizontal velocity field at a depth of 2 megameters, superimposed on a grayscale image of the surface magnetic field. The bottom three frames show grayscale images of shifts in the oscillation frequency, line width, and amplitude with the surface magnetic field superimposed as contours. These images show that the surface active regions produce several effects: they block flows, increase the oscillation frequencies, increase the line widths, and decrease the amplitudes. These effects suggest that the surface magnetic field substantially alters the physical conditions of the region immediately below the photosphere where the oscillations are reflected back down into the interior.