The Global Oscillation Network Group (GONG) Program

John Leibacher & the GONG Team

We continue to make excellent progress with the generation of local helioseismology science data products, the production of near real-time images of the farside of the Sun from GONG's network will soon be realized, and we are on track for the creation of a well understood zero-point for the magnetograms within the year. We have passed a design review for the replacement shelter, and are making progress toward the acquisition of the full data stream from the sites in near-real time.

Overall, the network has been operating very well, which is great, as we were privileged to welcome members of the Senate Appropriations VA/HUD-Independent Agencies subcommittee staff to the Udaipur site this January. All six sites are now capturing and transferring the 200 x 200 compressed images used for the generation of farside maps back to Tucson, and the pipeline processing is in place, though still undergoing some tuning before routine maps will be available on the Web.

We are moving ahead with a new design for the instrument's magnetogram modulator circuitry. A new microcontroller design will allow greater control of the switching between the two states of polarization and will reduce the systematic GONG magnetogram instrumental zero point error to 0.3 gauss over time (at least one day) to make them more useful for potential field extrapolations and studies of large-scale field changes. An internal review team approved the proposed prototype design, and sample microprocessors are being evaluated. Development of the prototype will continue over the next several months, culminating in a Prototype Design Review scheduled for July. A Prototype magnetic field pipeline to apply the zero-point correction, merge, temporal average, produce synoptic maps, and make the data available will be developed during this same period. A Magnetogram Users Group (MUG), established to help define the specifications of the processing, met at the AGU meeting in December and will meet in Tucson with the program staff at the beginning of March.

The program welcomes the newest GONGster, Candido Pinto, a recent PhD from the University of Arizona Optical Sciences department, as the group's Assistant Instrument Scientist. Candido is taking over for Jeff Sudol, who is leaving to pursue a teaching career.

Operations activities during the last quarter of 2004 focused on preventive maintenance (PM) visits to Udaipur and to El Teide in order to change the light-feed turret. The Udaipur PM began October 18, just after the shelter received a fresh coat of paint. It looks marvelous! The first task was to troubleshoot the tracking problem that appeared during repair of the earlier turret pitch motor problem. The fix involved adjusting an extremely large motor amplifier bias signal, which did not allow the turret stability necessary for the guider to lock. Next up was a problem involving the timing signals used to synchronize the system, which was tracked to a faulty global positioning system (GPS) receiver. With the instrument running again, the scheduled tasks could begin. A major project was the installation of a full set of earthquake protection equipment. Two days were required to secure the optical table, electronics rack, and uninterruptible power supply (UPS) cabinets with the new hardware. Now, all of the GONG instruments in regions with a history of earthquakes have been fitted with restraints on the heavy equipment. The alignment of the optical system was disturbed by the installation, requiring a full optical realignment. Some repair work to the shelter where cables entered through the wall was required to prevent further rainwater leakage to the interior. The camera, camera power supplies, amplifier chassis, and UPS were replaced, and the PM was completed November 3.

During the August PM to El Teide, electrical checks of the turret revealed some abnormal readings. A decision to replace the turret before the onset of winter was deemed prudent to decrease the risk of equipment damage, downtime, and the necessity of a turret replacement under much harsher conditions. The trip was planned

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for early November, immediately following the Udaipur PM. The replacement went well, but the alignment was hampered by extended periods of bad weather. In the meantime, the filter oven was changed because it had been previously noted that the bandpass was not well centered on the absorption line and could not be adjusted in the electronics. The latest modifications to the camera power supplies were installed in order to eliminate a problem found during the previous trip. The noisy lens slide was also replaced and the remote monitoring terminal was restarted. By extending their stay a few days, the team was able to complete the alignment. Once the El Teide turret was disassembled in Tucson, significant damage to the pitch motor was discovered, which validated the decision for an early replacement.

A few other events of note include an erroneous date stamp on some images from Big Bear. It was corrected by resetting the year register to the correct date. The image headers could be corrected after the fact. No impact on the data resulted. Also at Big Bear, the SUN workstation disk failed and a replacement workstation was shipped and installed. At Mauna Loa, a caching system DLT drive went bad and was replaced with an on-site spare. The CCD temperature of the Mauna Loa camera went high out of its normal operating range. Fortunately, the temperature stabilized at a higher temperature and impact on the data was minimal. The problem was found to be a failed cooling fan mounted on a board behind the camera. Site staff was able to install the spare and the temperature returned to the normal setting.

**Data Processing and Analysis**

After some hardware difficulties, we have now completed ring diagram analysis of 30 Carrington rotations, 25 of which are consecutive. We need to complete one last GONG month (month 85) to fill in the last two rotations of our backlog. When that is done, we will start processing the latest available GONG months (90–92, 13 February 2004 – 25 April 2004, rotations 2013–2017). Completion of that task will provide 38 consecutive rotations of subsurface flow maps. Mode frequencies for GONG months 90 through 92 (ending 31 May 2004) are now available.

The data reduction team is maintaining the cumulative backlog for calibrated data products at 86 days. Installation of the automated image rejection module is complete and undergoing testing. This will allow further reduction of the latency between data collection and delivery of the frequencies.

Progress has been made in implementing the automated processing of noon drift scans. Noon drift scans are now being obtained around the network on a frequent basis. Incorporation of these data into the determination of the angular orientation of the GONG images will improve the accuracy of the estimated position of solar north in the GONG data, and will eliminate our need for SoHO/Michelson Doppler Imager data as a fiducial.

The GONG scientific staff has been working on several projects. These include testing the sensitivity of global inversions to modern dynamo models; investigating the relationship between subsurface kinetic helicity and flare characteristics; time-distance measurements of the solar radius and the deep meridional flows; determination of the near-surface meridional flow from uninterrupted rotations; and, comparisons of frequencies derived from rings obtained in intensity and velocity as a function of disk position.

Since the planned upgrade to the modulator should produce much-improved magnetograms from GONG, we have begun work on the design of a magnetogram-processing pipeline. We have thus formed a Magnetogram Users Group (MUG). The initial membership consists of Nick Arge (Air Force Research Laboratory), Giuliana de Toma (High Altitude Observatory), Dave Hathaway (NASA Marshall Space Flight Center), Todd Hoeksema (Stanford University), and Yan Li (University of California, Berkeley Space Sciences Laboratory). Carl Henney, the SOLIS facility scientist, will act as an ex-officio member of the group. Janet Luhmann (University of California, Berkeley Space Sciences Laboratory) has joined the GONG Scientific Advisory Committee (SAC).

Changes in the meridional (north/south) flow below the surface from May 1995 through July 2001. This figure shows the difference in the time for waves to propagate in the north and south directions between points 8° to 12° apart. (These waves propagate to depths of 33 to 48 megameters.) The average difference in travel time over this time interval is shown on the right, and this average has been subtracted from the values for each 36-day-long GONG month to emphasize the changes. (A travel time difference of 1 second corresponds to a flow of approximately 10 meters per second, and the range of variations in the travel time corresponds to 0.8 seconds.)

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The Solar Physics Division of the American Astronomical Society has organized a series of summer schools to cover various aspects of solar physics. The inaugural summer school in 2005 focuses on helioseismology, and is being hosted by the High Altitude Observatory in Boulder, Colorado. See www.hao.ucar.edu/summerschool for more information.