Introduction

The Helioseismic and Magnetic Imager (HMI) investigation contract (NAS5-02139) between NASA and Stanford University has been in place since 27 September 2002. As of this date the contract has been modified 54 times.

The development of the HMI flight instrument was subcontracted to the Lockheed Martin Space System Company at its Lockheed-Martin Solar and Astrophysics Laboratory (LMSAL) in Palo Alto California. This subcontract is nearly closed with final disposition of parts and final billing remaining. The monthly (or bi-monthly) report for E/PO activities is also “attached” to this report. All periodic reports are available at http://hmi.stanford.edu/Status_Reports/. The quarterly reports from science Co-Investigators are also available and are considered to be attachments to this report. These monthly reports are written a week or two into the following month and include some status as of the date written. This section of the monthly report is written on 14 March 2011 to cover the activities at Stanford University in support of HMI and JSOC-SDP for February 2011. This report will continue in the style used during development until the LM subcontract for phase A-D is closed.
Status and Activities during February.

Administrative Issues:
We supported the HMI Quarterly review at GSFC on 11 February 2011, the anniversary of the SDO launch.

HMI Instrument:

Overview:
HMI continues to operate very well. While the final vector field sequence still may be changed the Doppler camera sequence is not expected to change. The vector sequence being used is likely to remain stable until substantial experience with the inversion and disambiguation code has been attained.

Instrument Operations:
The primary monthly reporting for operations infrastructure, staffing, etc are expected to be in the LMSAL AIA monthly report since AIA is contracted to perform the HMI operations. HMI science planning is done by Stanford so this section of the report will highlight issues and status of observation planning and accomplishments vs. the act of operations.

Rock Bush is the lead for HMI science operations and will in future months add some words here, if needed, to describe any issues.

Instrument Calibration:
The HMI calibration team is working on completing the instrument description and performance paper to be published prior to end of commissioning. The goal for submission to “Solar Physics” is as soon as possible. Most of the planned initial papers have been submitted and accepted and the Calibration team is hard at work finishing the remaining HMI paper. I have begun work on the HMI investigation paper.

HMI SDP:

HMI Level 1

The base level 1.0 program is complete and is running in a semi-automatic mode. We are now running regular lev1 NRT Line-of-Sight and NRT Vector processing with availability typically lagged from observation time by less than 30 minutes for the LOS products and less than 60 minutes for the 12-min Stokes and related products. The current status is available at: http://jsoc.stanford.edu/cgi-bin/ajax/show_jsoc_proc_status.html. Final level-1 processing finally commenced at the start of November. We are working forward in time with a lag of about 4 days after observation time. As of this writing, data from the 1 May is complete for LOS observables and Vector observables. There a several hours that will be reprocessed where they did not have final cosmic-ray hits removed properly on the first pass.
All of the hmi.X_45s and hmi.X_720s products have now been published are available to the community as soon as they are processed. Work is proceeding on an online document describing known limitations and other issues with these products.

**HMI Level 2**

Work is continuing on tasks for several standard product pipelines.

Work is proceeding on implementing the time-distance pipeline. Remaining work still includes primarily pipeline management scripts. Some of the code still does not make DRMS function calls but rather ad-hoc calls to open and write FITS files. The full integration into DRMS is still a near term goal. The code to splice processed inversion cubes into 360-degree maps is complete and the data is available online in test formats. Initial products are available and analysis work is proceeding in parallel to completing the pipeline processing. (unchanged since last month)

The “Rings” analysis pipeline is operating with tracked data cubes being generated and spectra computed, and analysis of flows generated. The Co-I provided 3-D inversions of this data are nearly operational and we have provided processor access to accommodate this processing (JILA group). The data series are in the sets of series hmi.rdX_Y where ‘rd’ means ‘ring-diagrams’ and ‘X’ is e.g. ‘Vpspec’ for power spectra and ‘Y’ is e.g. ‘fd05’, ‘fd15’, or ‘fd30’ for full disk tiles of 5, 15, and 30 degree tracked data cubes.

We now have 4 72-day intervals for global helioseismology analysis. Each completed interval is processed as soon as the level-1.5 data is available. The first 72-day interval began on 30 April with subsequent sections beginning on 2010.07.11, 2010.09.21, 2010.12.02, 2011.02.12.

Initial vector field products have been produced and are being tested for accuracy. The issue causing the delays is developing processes to manage the many cases where the field strength is too low for the inversion process to yield anything but noise. A number of concepts are being tested or planned. A reasonable implementation to suppress inflated noise in quiet regions is in place and the hmi.ME_720s data – i.e. inversion products – is available and will published soon. The disambiguation products will quickly follow and be called hmi.B_720s. Initial segments of this data are available upon request. An announcement in SolarNews is planned for one of the next two issues.

Pipeline programs to compute “synoptic” Carrington charts are complete for both synchronic frames and synchronic charts (like the traditional maps but with corrections for differential rotation). These products will also begin to be visible as “published” hmi series in very soon. Delayed only because of efforts focused on the vector field work.
The set of standard products is documented via the jsocwiki. See e.g. http://jsoc.stanford.edu/jsocwiki/Processing

**JSOC SDP:**

The new filesystems and disk that will help to mitigate against the failures we had in December will arrive in a few weeks and are expected to be available at the end of April.

**JSOC Data Record Management System (DRMS)**

The initial modifications made to isolate DRMS processing modules from the SUMS availability questions missed one case, where SUMS continued but a SUMS sub-service, the tape service, was unavailable. This has now been corrected and DRMS/SUMS is now more robust against SUMS or SUMS components being unavailable for short intervals during testing and modifications as described below.

**SUMS data Storage Unit Management System**

The arrival of the full load of data flow has exposed several weaknesses in the implementation of SUMS. One due to the much larger than designed data flow level resulting from catch-up processing of HMI data and one due to the requirements changes for handling AIA data.

The system was designed to archive and make available about 3 TB per day. We have been producing and archiving data at more than twice that rate. This has exposed a weakness in the assigning of tape drives for reading and writing with the result that tapes were being inserted and removed much too often. This has now been fixed (well, a work-around is in place) but needs some further refining for the long term in order to achieve the expected net bandwidth to the tapes.

The design of keeping several record’s worth of file data (segments) in a single “storage unit” in order to gain significant efficiencies in SUMS has not been used for AIA data since the remote DRMS users for AIA data wanted to be able to redistribute partial subsets of AIA series. Thus AIA now uses one storage unit per image as compared to HMI which packs between 500M and 1Gbyte per storage unit (as designed). The increased load, a factor of more than 10, on SUMS has shown that SUMS had not much more than a factor of 10 in performance as a single-threaded system. We are evaluating what changes are needed to mitigate this extra load. For instance, a modification to the “delete_series” code has reduced the time to delete a data series containing e.g. 20 million records from 6 hours to a few minutes. (This example was in removing test versions of AIA data products).
In contrast, the HMI “science” level products which remain online at all times, the requirements from the AIA team were for a data online retention of just 60 days for level-0 products and level-1 products. The plan was to keep lower cadence and lower resolution full image browse products combined with full cadence full resolution region cutouts for the duration of the mission. This was expected to be sufficient since it was believed that most use of AIA data would be for active region studies. The cost of taking the HMI approach was believed, in 2004 when the requirement was made, to be too high for the benefit. Two things have joined to convince most users that this requirement was incorrect. The first is due mainly to impatience. The second issue is more important – and that is that after seeing what the Sun does from initial AIA “movies” it is clear that the long range connections which have been long known, are much more important to the dynamics than was formerly appreciated. Now most AIA data users want and or need full disk data. After discussions with the SDO and LWS project leaders we have concluded that the scientifically required response is to keep the entire AIA level-1 product online for rapid access.

This new approach is complicated by two issues, first is cost. This adds about 250TB per year to the budgeted planned 150TB per year disk growth. A short term solution has been found for this issue. The second is due to more detailed technical/administrative difficulties. One of the needs for keeping the AIA level-1 data online is for the LMSAL AIA team to also have online access. In anticipation of the need for disk-speed access to the AIA data the JSOC procured and installed a 10gigabit per second leased connection between the JSOC-SDP and JSOC-AVC prior to launch. This should have been sufficient but LM rules require a firewall in this connection that makes LMSAL access to the SDP data much too slow. But we learned that the disks can be installed on the LMSAL SAN system and access from the SDP side allowed at full bandwidth. So this approach has been implemented. This took some minor modifications to DRMS and SUMS to allow seamless access.

This implementation is now in place but it makes SUMS significantly less robust since it now depends on the availability of a remote system which has proven to have a meat time between crashes of less than a day. We are monitoring the availability issue. The problems seem to be in some as yet not understood issue with serving NFS filesystems from the Apple SAN through the LM security routers. In the coming weeks a decision must be made to continue trying to make this system robust or to find another solution. Meanwhile, all of the December, January, February and some March data is now online but access is difficult and causes frequent DRMS/SUMS downtime when the NFS mounts vanish. Continued online access to AIA level data will depend on LMSAL obtaining sufficient disk for the AIA SAN and solving the technical problems with the interface to SUMS.

JSOC Database Development
No new capability. System is stable. We now have our consultants running in a maintenance support mode, making regular reports of system loads and making suggestions for tuning.

**JSOC Data Export**

Work is continuing on providing an easier to use user interface. The VSO (Virtual Solar Observatory) “daisy-chaining” of exported storage units is now functioning.

**JSOC Hardware**

The JSOC-SDP hardware is in place and in regular use. We very near the end of the hardware procurement and configuration for the beginning of the mission.

Part of the response to the December outage and the resulting delay in access to near real time data is to obtain the next increment of disk space sooner rather than later. We call this “D03/4” and it will be about 200TB and integrated into SUMS but we will not allow individual dataserries to span the current D02 file server and the new D03 and D04 servers. This will enable rapid reconfiguration to allow processing at least through lev1.5 NRT data if either file system is unavailable for more than a short time. It will also take some of the bandwidth load off D02. (D01 and D00 were used in early JSOC development.)

Initial tests with observables code and vector field inversion code show that there may be an important efficiency break with more processor cores having access to shared memory and for more memory than present in the initial JSOC computing array. We will investigate the benefits of adding four higher core-count nodes with larger memory per core once we have real vs. simulated data flowing. The class of machine that we are considering is similar to the “science analysis” node set that we have explicitly delayed until newer processors are released and the need is approaching critical. We have previously decided to postpone the purchase of this machine to the beginning of Phase-E when more of the analysis programs are better developed and we can determine the proper balance between processor core count and memory.

**HMI Science Team**

The HMI science team is busy learning the characteristics of the HMI data as compared to SOHO/MDI and other data sources and is evaluating methods to use on this newer and much much larger data volume to address their science questions. The Stanford SDO supported science team’s efforts to date are fully used to complete the initial characterization and calibration activities and making the data available to the broader community. That community is supported by other grants/contracts and reports their progress via papers and conferences. Summaries of recent accomplishments of the Stanford SDO team will be reported here as new science results develop after the initial push to get calibrated data is complete.

We are looking forward to new science to be presented at the SDO workshop in May.
Planned Activities for March

Get the Time-Distance and Vector field pipelines integrated into the pipeline environment.

Get the initial vector inversion and disambiguated products available to the community.

Near-term Milestones

Winter 2011  Most HMI science data products (Level-2) ready for release.

Attachments

This report, Co-I reports, and EPO reports which are considered attachments and available at http://hmi.stanford.edu/Status_Reports for convenience.