Status Reports for the Solar System Working Group

on Solar and Solar Terrestrial Missions in orbit

(H. Opgenoorth, 13th April 2005)

Ulysses

Mission Status

The spacecraft and its scientific payload are in good health, and no anomalies have occurred during the reporting period. The situation concerning the budget for NASA's contribution to the mission remains a concern. NASA has requested that the JPL Project formulate a Close-out Plan for Ulysses as a contingency measure in case funds are not restored. The project team at JPL has thus been instructed to draft a plan based on an assumed termination of routine spacecraft operations on 31 December 2005. The ESA Mission Operations Team members, located at JPL, have provided technical input where appropriate. This includes preparation of detailed end-of-mission procedures for spacecraft switch-off that is in any case required for the nominal end of mission in 2008.

On 1 May 2005, Ulysses will be at a radial distance of 5.1 AU from the Sun, and heliographic latitude 22º south of the solar equator.

Operations and Archive

All science operations during the reporting period have been nominal. Payload operations are being conducted according to the pre-determined power-sharing plan. The proposed switch-on of the Ulysses Gamma-ray Burst instrument to support post-launch calibrations of instruments on NASA's Swift gamma-ray burst satellite was deemed unnecessary based on the satisfactory in-orbit performance of the Swift payload. The Ulysses GRB instrument will therefore remain off until the on-board power/thermal situation improves (probably not before April 2007). The ESA Ulysses archive is accessible via the World Wide Web at URL: http://helio.esa.int/ulysses.

Science Highlights

The location of Jupiter with respect to the structure of the heliospheric magnetic field is precisely determined and non-central. This makes electrons emitted by Jupiter ideal tracers for studying particle propagation throughout the inner heliosphere. In mathematical terms, the propagation is usually characterized by a diffusion tensor. In recent work, Ulysses electron observations during the close (1992) and distant (2004) Jupiter encounters were analyzed to study the time dependence of the diffusion parameters. Since the observations from both periods were obtained during the declining phase of the solar cycle, it was expected that the electron intensities in 2004 would vary in the same way as the 1992 observations. This was found not to be the case, however. During the 2004 encounter, in contrast to 1992, Ulysses did not enter the Jovian magnetosphere but remained upstream of it. In mid-2002, the electron flux started increasing and displaying large short-term variations. These features lasted throughout the encounter, making the electron intensities less obviously correlated with the proximity to Jupiter compared with the first Jovian encounter. The suggestion is that the

diffusion coefficients, and in particular perpendicular diffusion in the polar direction, are highly time-dependent.

Solar and Heliospheric Observatory (SOHO)

Mission Status

The spacecraft status is nominal, with the High Gain Antenna (HGA) Z-axis in a fixed position.

On 22 March a nominal manoeuvre (station keeping, momentum management and roll) was performed and 0.1003 kg of fuel was used. The remaining hydrazine is 118 kg. The solar array degradation after 112 months of flight is 17.5%, which corresponds to 1.85% per year.

The Fine Sun Pointing Attitude Anomaly Detector (FSPAAD) triggered on 18 February, probably due to a particle blocking the FSPAAD again. It had been clear since the last ESR on 8 December 2004. The trigger did not result in an ESR since the output to the failure detection electronics had been left disabled. The FSPAAD was still blocked as of 1 April.

Operations and Archiving

All instruments are nominal and SOHO science operations are progressing smoothly.

During the March 2005 high gain antenna keyhole, VIRGO, GOLF, and MDI data were recorded continuously with the on-board recording patch. With a fall-back strategy in place to record only these instruments in case of ground problems, LASCO and CELIAS data could be recorded during most gaps. Normal recording mode (all instruments) was used occasionally thanks to good availability of 70-meter stations.

Links to the SOHO archives (including mirrors) are accessible at http://soho.estec.esa.nl/data/.

Science Highlights

Active region NOAA 10720 has turned out to be one of the most flaring regions of the last few years, with 15 M-class and 5 X-class flares between 14 and 22 January. The energetic particle event that was associated with the X7.1 on 20 January was the strongest radiation storm since October 1989, based on the flux level of the highest energy protons (> 100 MeV). This event was covered in near real-time in a special feature on the SOHO home page and attracted considerable media attention.

The SWAN team has determined the direction of the interstellar neutral hydrogen flow as it enters the inner heliosphere. It is found to be deflected relative to the helium flow by about 4 degrees. The most likely explanation of this deflection is a distortion of the heliosphere under the action of an ambient interstellar magnetic field. In this case, the helium flow vector and the hydrogen flow vector constrain the direction of the magnetic field and act as an interstellar magnetic compass. The results appeared in the 4 March issue of *Science* magazine.

Cluster

Mission Status

The four spacecraft and instruments are operating nominally. The short eclipse (less than 1 hour) season has been passed successfully. On spacecraft 1, one of the two batteries had a voltage drop about 3 minutes before the end of the eclipse and the second battery was not powerful enough to keep the spacecraft and instruments working. A switch over from the main on-board computer to the redundant one triggered and all instruments were switched off. After re-configuring the spacecraft, the instruments were successfully switched back on. To prevent this problem from happening again, a third battery was brought on line on each of the four spacecraft.

Operations and Archiving

JSOC and ESOC operations are continuing nominally. The data return from January 2005 to early March 2005 was above 99.1 %.

The Cluster Active Archive is progressing well. The first data have been delivered to the archive and it is planned to have most of 2001 data by May 2005. The start-up of the archive has been slower than expected but now with the formats and metadata dictionary defined for all instruments, we expect to recover the delay. The implementation review is planned for end of May 2005.

Science Highlights

Magnetic reconnection on the Earth's magnetopause is considered to be the most efficient mechanism for solar material to penetrate the Earth's magnetic shield. Complex geometrical properties of a transient and spatially confined type of reconnection have been observed in the past but so far not explained, due to high velocity of the magnetopause and the use of single spacecraft measurements. A case study based on multipoint measurements by the Cluster mission reveals, for the first time, a direct observation of a 3D magnetic field topology at the magnetopause, resulting from magnetic reconnection at multiple sites, which could explain these geometrical properties. It also shows a direct view of the entry of particles through the magnetopause.

High-speed flows of plasma (BBF), propagating from the magnetotail to the Earth at velocities higher than 300 kms^{-1}, are the carriers of decisive amounts of mass, energy and magnetic flux. A statistical study based on multipoint measurements by Cluster reveals, for the first time, their typical spatial scale. More than 1600 data points of Earthward flow events were used to deduce the size of the BBFs around 2–3 R_E in the dawn-dusk direction and 1.5–2 R_E in the north-south direction.

Double Star

Mission Status

The two spacecraft and the instruments are operating nominally. The magnetometer data are used to derive the attitude of the spacecraft. The satellite manufacturer, CAST, has made a

model of the evolution of the attitude of the two spacecraft. The spin axis of TC-1, the equatorial spacecraft, will have drifted by about 9 deg. at the end of 2006. On the other hand TC-2 spin axis is drifting faster and will reach 30 deg. by July 2006. There will therefore be enough power up to the end of mission (end of July 2005) and an extension up to end 2006 will be proposed.

The European instruments are operating nominally. Resets on PEACE (electron sensor) are still occurring. The instrument is now switched on and off five times along the orbit to be able to recover from eventual resets.

Operations and Archiving

The European Payload Operation System (EPOS) co-ordinates the operations for the seven European instruments on TC-1 and TC-2 and is running smoothly. ESOC acquires data on average about 3.3 hours per day with the VILSPA 2 antenna. The availability of the antenna was above 99 % between December 2004 and February 2005.

Science Highlights

Previous Cluster observations have shown that the flapping motions of the Earth's magnetotail are of internal origin and that waves are emitted from the central part of the tail and propagate toward the tail flanks. Using conjunctions between Double Star and Cluster, simultaneous observations were made both at 10-13 and 16-19 Re. Neutral sheet oscillations were observed by the Cluster and Double Star satellites on August 5, 2004. The study showed that such waves can be observed as close to the Earth as 11 Re, in the neighbourhood of the magnetotail hinge point.

Very intense, solar activity occurred between 03 and 13 November 2004, stimulating one of the most intense episodes of geomagnetic storms. The Dst Index recorded at Kyoto University over the period concerned reached a maximum value of –383 nT. The NUADU instrument on Double Star TC-2 observed from over the North Pole Energetic Neutral Atoms (ENAs) produced in association with the great enhancement of the ring current produced during the storm. The emissions wrapped around the Earth from midnight to dusk. The ENA intensity was strong at midnight because of the high flux of parent ions. An ENA image was recorded simultaneously by the HENA experiment on the IMAGE spacecraft which was at that time located in the Southern hemisphere, and thus viewed the ring current from the South. The general morphology displayed in the two images is consistent. These are the first comparisons made between dedicated ENA images of the ring current taken simultaneously from two separated points in space.

A total of 27 Papers have been submitted for the special Annales Geophysicae issue on first results from Double Star. They are now in the review cycle. A special session on results from Double Star and Cluster will take place at the EGU in Vienna. This will be the first time that Double Star results are shown in an international conference.