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Ulysses at high heliographic latitudes: an introduction

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Abstract. The unique *in situ* observations acquired by the scientific instrumentation on board the Ulysses spacecraft have provided, for the first time, a comprehensive, 3-dimensional view of the heliosphere from the solar equator to the poles near solar minimum. Since beginning its journey out of the ecliptic plane in February, 1992, Ulysses has acquired a wealth of truly new observations concerning the particles and fields in the previously unreachable high-latitude regions of the heliosphere. The articles that comprise this special issue are devoted to recent results from the high-latitude passes of Ulysses, including the rapid transit from the southern to the northern hemisphere. This paper serves as an introduction to these articles, and provides a short summary of the major scientific findings from the mission to date. Also included is a description of the various Ulysses data archives and their access.

Key words: Sun: solar wind – Sun: general – interplanetary medium – space vehicles

1. Introduction

Launched in October 1990, Ulysses is an exploratory mission being carried out jointly by ESA and NASA and has as its primary objective the study of the inner heliosphere in three dimensions. The importance of such a mission was recognised even at the dawn of the space era (e.g., Simpson et al. 1959), since it is generally accepted that the conditions found in the narrow band of heliographic latitudes available to observers in the ecliptic plane are not representative of the global structure of the inner heliosphere. Nevertheless, prior to Ulysses, attempts to understand the basic physical processes occurring within this environment have, by necessity, been based for the most part on observations made in or near the ecliptic plane. The highly successful Ulysses mission has now provided, for the first time, comprehensive in-situ measurements of the heliospheric particles and fields at distances from 1 to 5 AU from the Sun, and at essentially all solar latitudes.

Within the framework of the Ulysses project, ESA is responsible for the operation of the European-built spacecraft, while NASA provided the launch, the spacecraft's radioisotope thermoelectric power source, and is responsible for acquisition of data using the Deep Space Network of tracking stations. The scientific payload comprising nine hardware investigations was provided by international teams of scientists from Europe and the U.S.

The mission to date has provided a wealth of results addressing many aspects of solar and heliospheric science. In addition to numerous individual publications, seven collections of papers have appeared as special issues or sections of journals, each one focusing on a specific part of the mission (GRL 19, 1235–1314, 1992; Science 257, 1503–1577, 1992; JGR 98, 21111–21251, 1993; Planet. Space Sci. 41, 797–1108, 1993; Space Sci. Rev. 72, 1–494, 1995; Science 268, 1005–1036, 1995; GRL 22, 3297–3432, 1995). The papers in this special issue focus mainly on the results from the fast transit from the south to the north polar regions, and the northern polar pass.

This introductory paper is organized as follows: in Section 2, a brief description of the mission is given, followed in Section 3 by an overview of the scientific investigations. Section 4, which is intended to serve as a background to the papers following this one, comprises scientific highlights from the mission, together with a brief overview of some of the latest results. Finally, Section 5 is devoted to the various aspects of data archiving, including information on how to access the different Ulysses data sets.

2. General aspects of the mission

Following launch by the Space Shuttle, a combined IUS/PAM-S upper-stage was used to inject Ulysses into a direct Earth/Jupiter transfer orbit. A gravity-assist manoeuvre at Jupiter in February 1992 placed the spacecraft in its final Sun-centred out-of-ecliptic orbit, which has a perihelion distance of 1.3 AU and an aphelion of 5.4 AU. The orbital period is 6.2 years. Ulysses'

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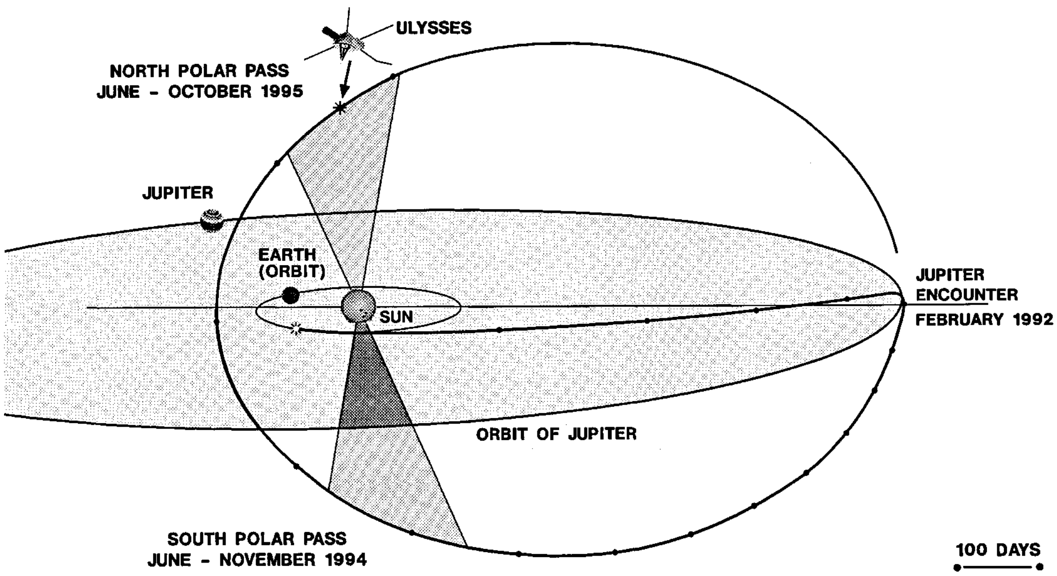

Fig. 1. The Ulysses prime mission orbit viewed from 15° above the ecliptic plane. Tick marks are shown at 100-day intervals. The launch date was 6 October, 1990 and perihelion passage occurred on 12 March, 1995. The position of the spacecraft at its maximum northern latitude is indicated

unique trajectory, shown in Fig. 1, has taken the spacecraft literally into the uncharted third dimension of the heliosphere. With the mission now in its seventh year, all spacecraft systems and the nine sets of instruments that make up the scientific payload continue to function well.

The prime mission, covering the period from launch up to the end of September 1995, included two polar passes, which are defined to be the parts of the trajectory when the spacecraft is above 70° heliographic latitude in either hemisphere. The first polar pass (over the south solar pole) commenced on 26 June 1994 and ended on 5 November, the second pass (north) occurring one year later (19 June – 29 September), making a total of 234 days (corresponding to approximately 9 solar rotations) above 70° latitude. The maximum heliographic latitude reached by Ulysses was the same in both hemispheres, namely 80.2°. Based on the unqualified scientific success of the mission to date, and the excellent health of the spacecraft and its payload, both ESA and NASA have undertaken to continue operating the spacecraft for a second orbit of the Sun. Constituting what is essentially a new mission, the so-called Second Solar Orbit will bring Ulysses back over the solar poles in 2000 and 2001 (see Table 1 and Fig. 2). In contrast to the high-latitude phase of the prime mission, which took place under quiet solar conditions, the second set of polar passes will occur close to solar maximum. The spacecraft is currently at moderate northern latitudes, heading out towards the orbit of Jupiter.

3. Scientific investigations

One of the major strengths of the mission is the breadth of its scientific investigations. Phenomena that are being studied by Ulysses include the solar wind, the heliospheric magnetic field, solar radio bursts and plasma waves, solar and interplanetary energetic particles, galactic cosmic rays, interstellar neutral gas, cosmic dust, solar X-rays and gamma-ray bursts. Clearly, the prime goal of all of these studies is to characterize the heliographic latitude dependence of the physical parameters involved. In addition, however, Ulysses' unique interplanetary orbit is highly suitable for carrying out measurements that are difficult to perform from the relative proximity of the Earth's orbit to the Sun. An important example of such measurements is the detection of interstellar pick-up ions. Other investigations carried out by Ulysses have included detailed interplanetary-physics studies during the in-ecliptic Earth-Jupiter phase, measurements in the Jovian magnetosphere during the Jupiter encounter, and radio-science investigations of the Sun's corona and the Io Plasma Torus using the spacecraft and ground telecommunication systems.

A summary of the nine instruments that make up the scientific payload is presented in Table 2. For a more complete description of the spacecraft and the investigations, the reader is referred to A&AS 92, 207–440, 1992.

4. Scientific highlights

Summaries of the key findings from the southern polar pass and pole-to-pole transit have been reported elsewhere (e.g. Smith & Marsden 1995; Marsden & Smith 1996a,b). The papers in this special issue, in addition to addressing new aspects of the data obtained during these periods, also focus on the results from the northern polar pass. Of particular interest in this context, as discussed below, are the north-south asymmetries reported by various authors. The following summary is not intended to be exhaustive, but rather attempts to illustrate the broad range of phenomena that are available for study using the unique data sets acquired by Ulysses.

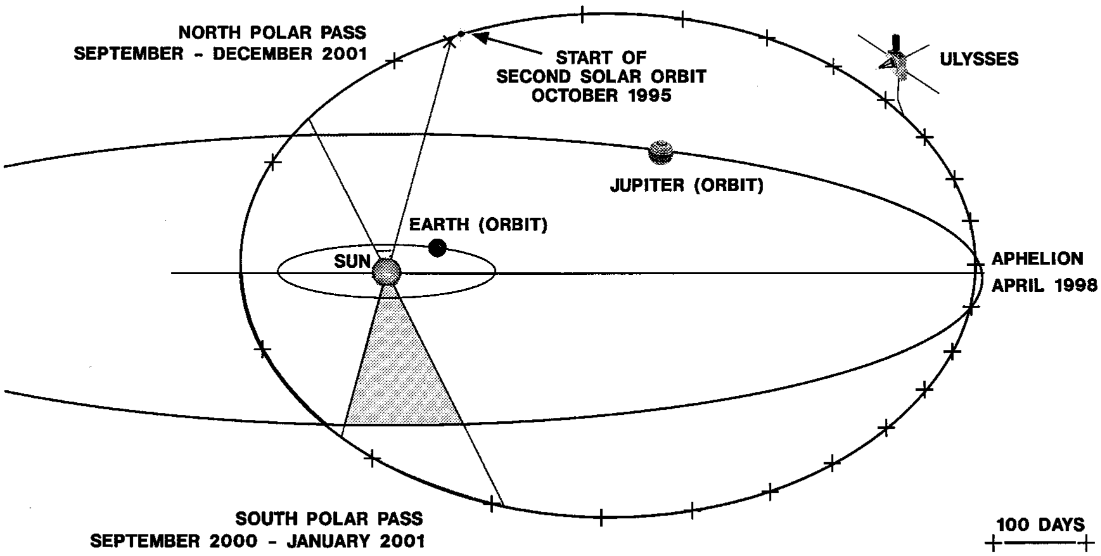

Fig. 2. The Ulysses second solar orbit viewed from above the ecliptic plane. Tick marks are shown at 100-day intervals

Table 1. Key dates in the Ulysses mission

Event		Date (Yr Mo Da)
Launch		1990 10 06
Jupiter flyby		1992 02 08
1st Polar Pass		
	start	1994 06 26
	max. latitude	1994 09 13
	end	1994 11 05
1st Perihelion (1.34 AU)		1995 03 12
2nd Polar Pass		
	start	1995 06 19
	max. latitude	1995 07 31
	end	1995 09 29
Start of 2nd Solar Orbit		1995 10 01
Aphelion (5.4 AU)		1998 04 15
3rd Polar Pass		
	start	2000 09 08
	max. latitude	2000 11 27
	end	2001 01 16
2nd Perihelion (1.34 AU)		2001 05 26
4th Polar Pass		
	start	2001 09 03
	max. latitude	2001 10 13
End of mission		2001 12 31

The general picture to have emerged from the Ulysses data regarding the global, 3-dimensional structure of the solar wind at, or near, solar minimum is that the high latitude solar wind originating from the polar coronal holes is characterized by a fast, uniform flow, with an average speed of 750 km s^{-1}. Slow to medium speed wind streams originating in the coronal streamer belt are confined to a relatively narrow range of latitudes on either side of the heliographic equator. This band, in which the majority of solar wind variability is observed, also contains the heliospheric current sheet (HCS) that separates the oppositely directed large-scale magnetic fields originating in the two hemispheres. Although the streamer belt and HCS are approximately aligned with the heliographic equator at solar minimum, they both exhibit significant warping, thereby allowing stream interactions to occur. At the time Ulysses made its rapid pole-to-pole passage in 1994/95, the band of solar wind variability at the position of the spacecraft (1.4 AU) occupied some 43° in latitude, from −22° to +21° (Gosling et al. 1995; Phillips et al. 1995). This region was noticeably narrower compared with situation in 1993 when the spacecraft left the slow to medium solar wind at −35° latitude on its way to the south polar regions, consistent with the evolution of the streamer belt towards solar minimum. In addition to its higher average speed, the solar wind at high latitudes has higher proton temperature and momentum flux than low-latitude solar wind, but lower average number density (e.g. Goldstein et al. 1996).

Another key result from the Ulysses polar passes concerns the global structure of the heliospheric magnetic field. Ulysses observations have revealed that the radial component of the magnetic field is latitude-independent, contrary to the majority of model predictions (Smith & Balogh 1995). This result implies that the HCS is the dominant factor in determining the radial field at the orbit of Ulysses, rather than the solar field at the poles. In considering the origin of the uniform radial field, Suess et al. (1996) argue that, while the isotropic thermal pressure in the solar wind observed by Ulysses would give rise to significant meridional transport of magnetic flux beyond 10 $R_\odot$ (the observed pressure profile shows a ‘bump’ at low latitudes due to heating by stream interactions), it is the perpendicular pressure that drives meridional flux transport, and this is much smaller than the isotropic pressure.

Table 2. The Ulysses scientific investigations (hardware and radio science)

Investigation	Acronym	Principal Investigator	Measurement
Magnetic field	VHM/FGM	A. Balogh Imperial College, London (UK)	Spatial and temporal variations of the heliospheric magnetic field: 0.01 to 44 000 nT
Solar wind plasma	SWOOPS	J.L. Phillips Los Alamos Nat. Lab. (USA)	Solar wind ions: 260 eV to 35 keV/e solar wind electrons: 0.8 to 860 eV
Solar wind ion composition	SWICS	J. Geiss ISSI, Bern (CH) G. Gloeckler Univ. of Maryland (USA)	Elemental and ionic charge composition, temperature and mean speed of solar wind ions: 145 km s^{-1} (H^+) to 1350 km s^{-1} (Fe^{8+})
Radio and plasma waves	URAP	R.J. MacDowall NASA/GSFC (USA)	Plasma waves, solar radio bursts, electron density and electric field: 0 to 60 kHz (plasma waves) 1 to 940 kHz (radio) 10 to 500 Hz (magnetic)
Energetic particles, interstellar neutral gas	EPAC/ GAS	E. Keppler MPAe, Lindau (D)	Energetic ion composition: 80 keV/n to 15 MeV/n; neutral He atoms
Low-energy ions and electrons	HI-SCALE	L.J. Lanzerotti AT&T Bell Labs. (USA)	Energetic ions: 50 keV to 5 MeV Energetic electrons: 30 to 300 keV
Cosmic rays and solar particles	COSPIN	J.A. Simpson Univ. of Chicago (USA)	Energetic particles and cosmic rays: ions: 0.3 to 600 MeV/n electrons: 4 to 2000 MeV
Solar x-rays and cosmic gamma-ray bursts	GRB	K. Hurley UC Berkeley (USA)	Solar flare x-rays and gamma-bursts: 15 to 150 keV
Cosmic dust	DUST	E. Gruen MPK Heidelberg (D)	Dust particles: 10^{-16} to 10^{-7} g
Radio science (coronal sounding)	SCE	M.K. Bird Univ. of Bonn (D)	Density, velocity and turbulence spectra in solar corona and solar wind
Radio science (gravitational wave search)	GWE	B. Bertotti Univ. of Pavia (I)	Doppler shifts in S/C radio signal

A fundamental question that has been answered by Ulysses relates to the presence of large-scale directional fluctuations in the polar heliospheric magnetic field. Prior to the launch of Ulysses, Jokipii & Kota (1989) suggested that the classical picture of smooth, near-radial polar magnetic field lines would be modified by the effects of random walk of the field footpoints resulting from supergranulation motion in the photosphere. This stochastic motion would lead to large-scale transverse fluctuations in the polar fields, which in turn would impede the access of cosmic ray particles to the inner heliosphere over the poles. The data from Ulysses' polar passes have confirmed both the existence of the field fluctuations (e.g. Balogh et al. 1995), and the absence of large latitudinal gradients in the fluxes of cosmic ray particles (Simpson et al. 1995). Of particular interest is the latitude distribution of the so-called anomalous cosmic ray component (ACR), generally thought to be singly-charged interstellar ions (Mall et al. 1996) that have been accelerated to MeV energies at the solar wind termination shock. Here, Ulysses results show a modest positive latitudinal gradient for ACR O, N and Ne of ∼2% per degree (Trattner et al. 1996), qualitively in agreement with models in which the acceleration takes place largely at the poles of the heliosphere, the ACR subsequently diffusing and drifting down to the equatorial regions. Addressing the question of electron latitudinal gradients at MeV energies, Ferrando et al. (1996) find no excess in galactic cosmic ray electron flux over the poles, contrary to the claim by Simnett et al. (1995).

In addition to latitudinal effects, the energetic particle and cosmic ray measurements made by Ulysses have revealed a striking global periodic variation. Recurrent increases in the low-energy (∼50 keV to ∼10 MeV protons; ∼50 keV electrons) particle flux with ∼26-day period were observed up to high latitudes in the southern hemisphere. On the other hand, at energies $\gtrsim$100 MeV, the nucleon intensities show corresponding periodic decreases (e.g. Keppler et al. 1995, 1996; Lanzerotti et al. 1995, 1996; Simpson et al. 1995). Both of these phenomena are thought to be associated with Corotating Interaction Regions (CIR) that form as a consequence of stream interactions between fast and slow solar wind flows. CIR shocks accelerate the low-energy particles, while the magnetic field compressions associated with the stream interactions impede the access of high-energy particles to the inner heliosphere. In the light of the first comprehensive study of the 3-dimensional evolution of CIRs (Gosling et al. 1993), the question raised by the Ulysses measurements is how do the effects of CIRs operate at high latitudes, where the CIRs themselves are no longer seen? A variety of models have been developed to explain the observations (e.g., Simnett & Roelof 1995; Kota & Jokipii 1995; Quenby et al. 1996; Fisk 1996), but a consensus has yet to be reached.

Now that Ulysses has completed polar passes in both hemispheres, an obvious question to be answered is: do the data reveal significant north-south asymmetries? This is clearly one aspect where the out-of-ecliptic studies would have benefitted from the simultaneous observations available with the original two-spacecraft mission. Nevertheless, the rapid pole-to-pole scan, together with the slowly changing activity conditions characteristic of solar minimum, have enabled a comparison of the two hemispheres to be made whereby, at least to first order, temporal effects can be neglected. Such a comparison reveals modest north-south asymmetries in a number of the data sets. Examining spatial gradients in solar wind parameters, Goldstein et al. (1996) find the average solar wind speed at latitudes greater than 40° to be $\sim$15–25 km s^{-1} higher in the north than in the south, qualitatively consistent with corresponding open coronal field line expansion factors computed using magnetogram data (Wang & Sheeley 1990). Another solar wind asymmetry, presently not understood, is found in the radial proton temperature gradient, which is steeper in the north than in the south.

North-south asymmetries are also reported in the low-energy particle measurements (Lanzerotti et al. 1996). The recurrent increases in the flux of 50 keV electrons with a period of $\sim$26 days referred to above were seen up to 80° south latitude, but not at high latitudes in the northern hemisphere. Comparison with in-ecliptic data reveals that solar and interplanetary activity persisted through 1995, implying that the lack of variations seen in the north is a spatial rather than temporal effect. None of the models proposed to date to explain the $\sim$26-day recurrent behaviour would predict an intrinsic north-south asymmetry, leading the authors to suggest that the observations result from differences in the physical conditions in the two hemispheres. At higher energies, the cosmic ray flux observed by Ulysses, including the ACR component, was higher at a given heliographic latitude in the north than in the south by up to 50% (Heber et al. 1996; Lanzerotti et al. 1996; Trattner et al. 1996).

Not all data show north-south asymmetries. For example, the magnitude of the radial magnetic field, when corrected for heliocentric distance, and the amplitude and radial gradient of the field variances, are the same in both hemispheres (Forsyth et al. 1996). Using measurements from the Ulysses plasma wave experiment, Hoang et al. (1996) find no significant asymmetry between the solar wind electron temperature and density profiles derived from thermal noise spectroscopy for the northern and southern hemispheres. Similarly, when comparing directional discontinuities (DDs) and tangential discontinuities (TDs) in the north and south polar wind, Tsurutani et al. (1996) find no differences in the rate of occurrence of DDs and TDs between the two hemispheres. Further observations as Ulysses moves out to aphelion at the orbit of Jupiter may help to resolve the origin of the various asymmetries and/or symmetries in the data. Since many of the phenomena are affected to a greater or lesser degree by the heliospheric current sheet, it is likely that topology of the HCS will be important. In particular, the latitude excursion of the warped HCS has been found to be different in the two hemispheres (Heber et al. 1996), possibly accounting for the observations.

As stated earlier, this brief summary of scientific results from Ulysses cannot do justice to the wealth of research being conducted with data from the first-ever exploration of the high-latitude heliosphere. Rather, it is intended to provide a background to the papers contained in this special issue. In addition to the problems discussed above, these address a diverse range of topics that includes the search for interplanetary signatures of coronal polar plumes (McComas et al. 1996; Poletto et al. 1996), interplanetary signatures of CMEs (Weiss et al. 1996; Bothmer et al. 1996), and multi-point observations of type III radio bursts (Leblanc et al. 1996; Barrow et al. 1996).

5. Ulysses data archiving

The data products generated by the Ulysses investigations are described in the Ulysses Science Data Management Plan approved in Nov. 1994 by the NASA and ESA Ulysses Project Scientists, Ulysses project staff at NASA's Jet Propulsion Laboratory, NASA Headquarter's Space Physics Division, and NASA's National Space Science Data Center (NSSDC) at NASA Goddard Space Flight Center. According to this plan, Ulysses experiment Principal Investigators retain proprietary rights for publication of the data up to one year, after which appropriate data sets are to be submitted to NASA and ESA for archiving. More recently, NASA policies for other missions have moved away from assurance of proprietary publication rights in the first year but have retained the provision that periods of up one year be allowed for validation purposes. Data provided before expiration of this validation period may in some cases become publicly accessible for survey purposes but need not be of sufficient quality for use in scientific publications.

The principal public archives for Ulysses data include NSSDC, the recently created ESA Archive for Ulysses data in ESA's Space Science Department at Estec (Tranquille et al. 1996), World Data Center A for Rockets and Satellites (co-located with NSSDC for service to non-U.S. requesters), and the Planetary Plasma Interactions Discipline Node of NASA's Planetary Data System (PDS/PPI) at the University of the University of California at Los Angeles. Some Ulysses investigators are directly distributing their data, either quicklook or archive quality, via Internet and the evolving World Wide Web, while also using this method to submit the data to the public archives. The ESA Ulysses Project maintains its own archive of on-line

Table 3. Ulysses data sets at NSSDC, ESA and other sites

Data set	PI or organization	Brief data set description	Archive location
SEDR	Ulysses Project	Spacecraft ephemeris data – heliocentric & planetocentric	NSSDC
VHM/FGM	A. Balogh	1-min. & 1-hr ave. magnetic field – interplanetary RTN coordinates	NSSDC & ESA
SWOOPS	J.L. Phillips	High-resoln. & 1-hr ave. solar wind ions High-resoln. solar wind electrons	NSSDC & ESA
SWICS	J. Geiss G. Gloeckler	3.5-hr ave. solar wind composition	NSSDC & ESA
URAP	R.J. MacDowall	3-hr summary plots (microfiche) Daily summary plots (PostScript)	NSSDC
		10-min average/peak intensity – PFR, RAR, WFB, WFE 144-sec ave. intensity (RAR)	NSSDC & ESA
HI-SCALE	L.J. Lanzerotti	Hourly spin-averaged rates	NSSDC & ESA
		Hourly averaged sectored fluxes	Univ. of Kansas (WWW)
		Ion & electron anisotropy plots	NSSDC & ESA
		HI-SCALE Data Analysis Handbook	NSSDC
EPAC	E. Keppler	1-hr ave. particle fluxes	NSSDC & ESA
COSPIN	J.A. Simpson	10-min ion & electron fluxes – 5 sensors (AT, LET, HET, KET & HFT)	NSSDC & ESA
		Daily HET proton & helium fluxes; Mission & six-month survey plots and lists	Univ. of Chicago (WWW)
DUST	E. Gruen	Dust particle event list	NSSDC & ESA
GRB	K. Hurley	0.25–2 sec counting rates – integral & omnidirectional	NSSDC & ESA

data at ESA's Ulysses Data System (UDS) at Estec, but access to this archive is restricted to members of Ulysses investigation teams and is not available to the public. UDS often serves, however, as an intermediate staging point for submission of data to the public archives.

NSSDC serves as the primary archive for interplanetary data and as the deep archive for all Ulysses data submitted to NASA. Planetary magnetosphere data related to the February 1992 Ulysses flyby of Jupiter have been submitted to the Planetary Plasma Interactions (PPI) Discipline Node of the Planetary Data System (PDS) and will later be deep archived (typically on CD-ROMs) at, and distributed by, NSSDC, after PDS processing and peer review. The ESA Archive for Ulysses data will be the central repository and distribution point in Europe during the mission's operational lifetime. Flow of data into the NASA and ESA public archives commenced in late 1994 and was greatly expedited by electronic transfers of digital data over the Internet from many Ulysses experiment teams and from UDS.

Table 3 lists specific data sets that have thus far been defined by the Ulysses Project and various investigation teams for archiving from the in-ecliptic and out-of-ecliptic phases of the Ulysses mission. This table includes the data set type (e.g., VHM/FGM for magnetic field, SEDR for spacecraft ephemeris), the responsible Principal Investigator, brief description of each data set type, and the institution(s) currently providing primary public access to the data. The time resolutions extend from 0.5-second rates (GRB integral rates) to daily (COSPIN/HET particle fluxes) averages for data consisting of counting rates, particle fluxes and anistropies, solar wind plasma parameters, magnetic field vectors (RTN system) and magnitudes, electric and magnetic plasma wave and radio intensities, event listings for dust particles, and spacecraft coordinates for ephemeris data. Not shown in Table 3 are specific listings for data submitted to PPI-PDS from the Jupiter encounter interval, January 25 to February 17, 1992, which included data from before the first crossing of the Jovian bow shock through the final exit into the solar wind.

Most of the data sets in Table 3 are available in easy-to-use ASCII format and are accompanied by informative data set descriptions. In several instances, comprehensive user guides have

Table 4. Addresses of Ulysses-related data services on the World Wide Web

ESA Ulysses Project Page	http://helio.estec.esa.nl/ulysses/
NASA Ulysses Project Page	http://ulysses.jpl.nasa.gov/
NASA Space Physics Data System	http://spds.nasa.gov/
NSSDC Ulysses Mission Page	http://nssdc.gsfc.nasa.gov/cgi-bin/database/www-nmc?90-090B
ESA Archive for Ulysses Data	http://helio.estec.esa.nl/ulysses/archive/
PDS/PPI Home Page	http://www.igpp.ucla.edu/ssc/pdsppi/Welcome.html
NSSDC COHO Anonymous FTP service	http://nssdca.gsfc.nasa.gov/htbin/htdir/anon_dir/coho/
NSSDC COHOWeb service	http://nssdc.gsfc.nasa.gov/cohoweb/cw.html
NSSDC SPYCAT service for Ulysses Data on NDADS	http://nssdc.gsfc.nasa.gov/space/ndads/spycat.html
VHM/FGM Home Page at Imperial College, London	http://www.sp.ph.ic.ac.uk/Ulysses/
SWOOPS Home Page at LANL	http://sst.lanl.gov/nis-projects/swoops
SWICS Home Page at Univ. of Maryland	http://space.umd.edu/UMD_sensors/uls_swics.html
URAP Home Page at GSFC	http://urap.gsfc.nasa.gov/www/urap_homepage.html
EPAC Home Page at MPI/Lindau	http://www.mpae.gwdg.de/mpae_projects/ULYSSES/ULYSSES.html
HI-SCALE Home Page at Univ. of Kansas	http://kuspa1.phsx.ukans.edu:8000/∼ulysses/index.html
HI-SCALE Home Page at JHU/APL	http://sd-www.jhuapl.edu/Ulysses/hiscale.html
COSPIN/LET Home Page at ESTEC	http://helio.estec.esa.nl/ssd/let.html
COSPIN/HET Home Page at Univ. of Chicago	file://odysseus.uchicago.edu/WWW/Simpson/Ulysses.html
Ulysses at the Univ. of Arizona	http://xlr8.lpl.arizona.edu/ulysses.html

been provided for more detailed information on experimental hardware, science objectives, measured parameters, data processing, and data quality issues. The PDS archive also consists of ASCII files, most of which contain one day of data.

5.1. Public access to Ulysses data

All of the data sets from Ulysses investigations received by the ESA and NASA public archives are immediately eligible for public release, except (a) Experimenter Data Record (EDR) and related data received monthly by NSSDC directly from the Ulysses Project, and (b) data held in proprietary status for Ulysses investigators by the Ulysses Data System. Access may also be limited for Jupiter data undergoing peer review through PPI-PDS. In some cases data sets undergoing validation or peer review may be released generally or to individuals at the discretion of the responsible Principal Investigator.

Many of the archived data sets in Table 3 have been staged for public on-line access after receipt at NSSDC through the Coordinated Heliospheric Observations (COHO) directory at the NSSDC Anonymous FTP site (anonymous@nssdca.gsfc.nasa.gov) and on the World Wide Web, the URL addresses for the latter being given in Table 4. Hourly key parameter data for magnetic fields and solar wind plasma (later to be followed by selected energetic particle and other data) from Ulysses and other interplanetary space physics experiments can be selected, browsed graphically, and retrieved via NSSDC's COHOWeb service on the Web. Queries about NSSDC data online, near-line, or on off-line media (e.g., magnetic or digital tapes, diskettes, etc.) may be addressed via Internet or other means (see below) to NSSDC's Coordinated User Request Office (CRUSO).

On-line data stored at the ESA Archive for Ulysses data can be accessed electronically by Anonymous FTP (anonymous@helio.estec.esa.nl) or through the World Wide Web (see Table 4). Summary plots of selected parameters (in GIF and PostScript formats) for most experiments are also available for viewing and downloading. The software used to generate these plots has been interfaced to the ESA archive Web site to allow customized graphical output. Ulysses data sets are also stored on CD-ROMs for deep archiving and for distribution upon request.

All of the Ulysses Jupiter data are kept on-line at PDS/PPI and can be accessed electronically through the World Wide Web (see Table 4). The entire Ulysses Jupiter data collection will be available from PDS/PPI and NSSDC on CD-ROM by mid-1996. Questions about general Ulysses data archiving and access may be directed to Dr. Cecil Tranquille (email: ctranqui@estcs1.estec.esa.nl, phone: 31-71-5653587, fax: 31-71-5655420) in Europe or to Dr. John F. Cooper (email: jcooper@nssdca.gsfc.nasa.gov, phone: 301-441-4188, fax: 301-441-9486) in the U.S.A.. Specific questions about Jupiter data may also be directed to Steve Joy at PPI-PDS (email: sjoy@galsun.igpp.ucla.edu, phone: 310-825-3506).

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