DISCOS DATABASE AND WEB INTERFACE

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In order to support Space Debris studies the European Space Agency is maintaining a ***Database and Information System Characterising Objects in Space*** **(DISCOS)**, run by the Space Debris Group at the Mission Analysis Section of ESOC, Darmstadt.

This database contains characteristic information on all objects ever launched into space since Sputnik 1, as well as other related information, including images, which can be accessed via a Web interface. This interface also allows users to use ESA's MASTER model and Sattrack satellite tracking tool, to download the DISPAD reports, to request solar and geomagnetic activity data or use a set of drawing tools. The main features of the DISCOS database and its interface are here presented.

1. INTRODUCTION

DISCOS, as its name says, is a **D**atabase and **I**nformation **S**ystem **C**haracterising **O**bjects in **S**pace. The latest versions of the database as well as the Web interface have been developed by GMV, Spain, with contributions from eta_max Space, Germany, and are maintained by the Space Debris Group at the Mission Analysis Section of ESOC, Darmstadt.

The database contains information on all catalogued objects ever launched into space since Sputnik 1 in 1957. These data support the *DISCOS Space Data Publication System (DISPAD),* which produces tabular reports of the DISCOS contents, and are also being used as part of the Common and Re-entry databases, which are provided as an ESA service to the Inter Agency Space Debris Co-ordination Committee (IADC) of all major spacefaring nations. Many space debris studies also benefit from these data.

DISCOS provides a Web interface that makes the data and other related tools accessible to registered users from all over the world. According to the different agreements between ESA/ESOC and the data providers, the following can become registered users:

- Research institutions, government organisations, industry or academia of an ESA member state
- Entities within the US authorised by NASA

2. TECHNICAL ASPECTS

The DISCOS database has been developed using the Oracle 8*i* kernel database and Oracle Internet Application Server 8*i* (*i*AS) as the web server (for the user interface).

Many programming languages have been used to build this system. The main ones being: SQL, PL/SQL, FORTRAN and Perl for the web interface and to insert new data into the database; DISSPLA and PV-Wave graphical tools to produce the images; LaTeX-2_ document processing system to produce the documentation, and latex2html for the on-line help.

3. DISCOS CONTENTS

DISCOS contains characteristic information on more than 26,500 catalogued objects, including the international designator (or COSPAR identification number), the NORAD satellite number, the name, the country it belongs to, mass, shape and dimensions, and cross-sectional areas. The type of the object (whether it is a payload or a rocket body or fragment/debris) is also stored, as well as the re-entry epoch if the object has already decayed. In the case of a payload, mission details and spacecraft data are also available. All this data is updated on a monthly basis from different sources.

At present there are about 8,300 catalogued objects orbiting the Earth, whose orbital parameters are updated on a daily basis in the DISCOS database. But a historical record of each object's orbital elements since 1990 is also maintained, at a rate of approximately one element set per object per week, adding up to nearly 4 million records.

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Details on all launches performed up to now are also kept (including launch failures), with the launch date, the launch site and launch vehicle used. Moreover DISCOS also contains related launcher information, such as engines, stages, fuels, oxidizers and pressurants.

The DISCOS system provides a tool to calculate lifetimes of on-orbit objects, and estimates the re-entry epoch. It also detects decaying hazardous objects (due to, for instance, their mass or dangerous payload – e.g. nuclear power sources). This data is regularly maintained and updated in the database.

Other information includes fragmentation events (event epoch, number of catalogued debris, assessed cause…), bibliographic references on space debris related studies, etc.

4. INFORMATION SOURCES

During the years (the first version of DISCOS was developed in 1990), a lot of different sources have been used to provide the system with data.

Orbital data is provided by USSPACECOM via NASA in the form of Two Line Elements, more commonly known as TLEs, and is limited to users who have corresponding bilateral agreements with NASA.

Object and launch data initially came from the R.A.E. Table of Earth Satellites [1]. After it was no longer published, data was mainly provided by Molniya Space Consultancy of Whitton/UK, Space Flight Data Applications of Hobro/Denmark, and more recently from Jonathan McDowell of Cambridge/USA.

Fragmentation information was compiled from Teledyne Brown Engineering's History of On-Orbit Satellite Fragmentations [2]. Nowadays it is NASA who produces a similar report with the same name, and provides this data to DISCOS.

Other sources used to complete the contents in DISCOS have been Jane's Space Directory [3], the Encyclopaedia Astronautica [4], the Space Launch Systems [5], the International Launch Site Guide [6] or NASA's Satellite Situation Report amongst others.

5. DISCOS WEB INTERFACE

The DISCOS system provides a Web Interface that registered users all over the world. It consists of a private part accessible to registered users only, and a restricted public part available to any non-registered user.

In order to make navigation easier to users, a help link is available in each one of the web pages that points to the appropriate sections of the on-line user manual.

Fig. 1. DISCOS Web Interface - Main Page

The main features of the web interface will be described in the following sections.

5.1 SQL Interface

The SQL interface presents an easy-to-use way to access data, for users non-familiarised with the SQL (Structured Query Language) language. Several links are available that will guide the user to easily construct an SQL sentence to get the required data for his/her specific needs.
If the user is already familiarised with the SQL language, a "free format" text box is also available for the user to write his/her own query.

These queries can be saved and in later sessions, loaded and executed. Apart from each user's specific queries (accessible only to that user), there are other queries available to all users that are considered of general interest and can serve as a guide to write more complex queries.

The output data will appear in tabular format, either as an HTML table or in ASCII format, to be copied and pasted to any text editor.

5.2 DISSPLA Graphical Tool

DISCOS provides an interface to the DISSPLA graphical tool, where users can choose to produce 2-D and 3-D bar diagrams, curves, scatter and shaded plots, pie plots, rose diagrams or polar plots, with interactive definition of input data, plot styles, annotations, and output file formats. The produced plot can then be downloaded to the user's local computer.

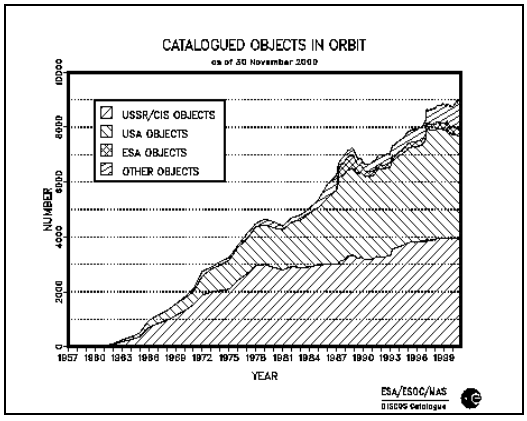
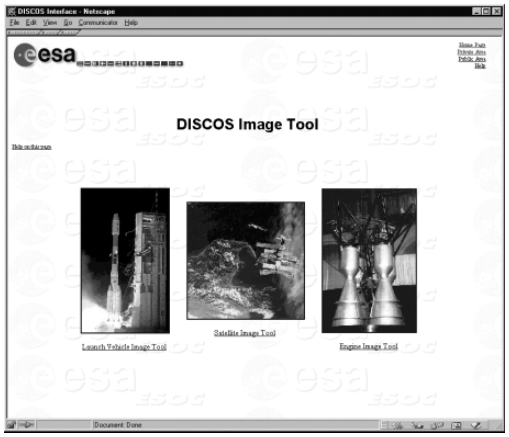


Fig. 2. Example of a DISSPLA graphic

5.3 DISCOS Image Tool

DISCOS users have the possibility to view images of launch vehicles, spacecraft or engines stored in the database. By selecting one of the links (or photographs) shown in the Image Tool main page, users will be able to choose from a selection list the desired object. In the case of spacecraft images, the user also has the option to write the COSPAR identification number or the satellite number in the text boxes shown.



5.4 DISPAD Tool

DISPAD is a system for the extraction of information from the DISCOS database and for the production of derived LaTeX formatted documents.

The DISPAD Interface is a tool designed to offer DISCOS users the ability to access up to three documents that have been produced by the DISPAD tool:

- EsaROS: ESA Register of Objects in Space.
- EsaLOF: ESA Log of On-Orbit Fragmentations.
- EsaLOG: ESA Log of Objects in or near the Geostationary ring.

In these documents, along with the tabular information, some statistical data are provided as tabular summaries and/or as graphical charts.

The documents can be downloaded whole or in ten-page sections.

5.5 Satellite Tracking

The Satellite Tracking Interface allows DISCOS users to generate satellite station coverage information for a user-defined or system-provided observer location, and for a user-selected object. The object can be chosen from a public subset of the USSpaceCom Catalog (in the case of public users) or from the DISCOS database (in the case of registered users).

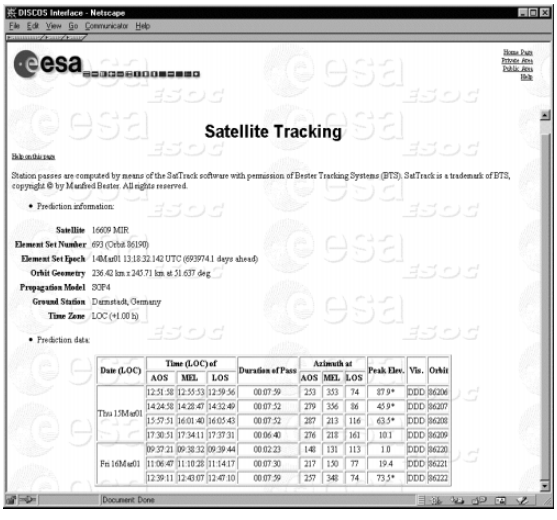


Fig. 4. Satellite Tracking Interface – Computed station passes

5.6 MASTER Model Interface

The MASTER model offers a full three-dimensional description of the terrestrial debris distribution reaching from LEO up to the GEO region. It consists of an *Analyst Application* with full orbit information and high-resolution flux results, and a faster, slightly simplified *Engineering Application*.

The WWW interface to MASTER is part of the Internet implementation of the DISCOS database. This interface is capable of providing the full functionality of a local MASTER installation to a remote user via dynamic HTML pages. In addition, an interface to DISCOS enables registered users to import recent object data into MASTER for further analysis.

The 2- and 3-dimensional graphical outputs can be edited (titles, labels, legends…) and downloaded to the user's local computer, as well as the output data files.

5.7 Solar and Geomagnetic Activity Data

DISCOS offers registered and non-registered users the possibility of obtaining information on solar and geomagnetic activity. This information includes records and forecasts in two available formats: Monthly mean observation or prediction data, or Daily observation data.

Information can be obtained in one of the three available options: HTML format, ASCII format or graph.

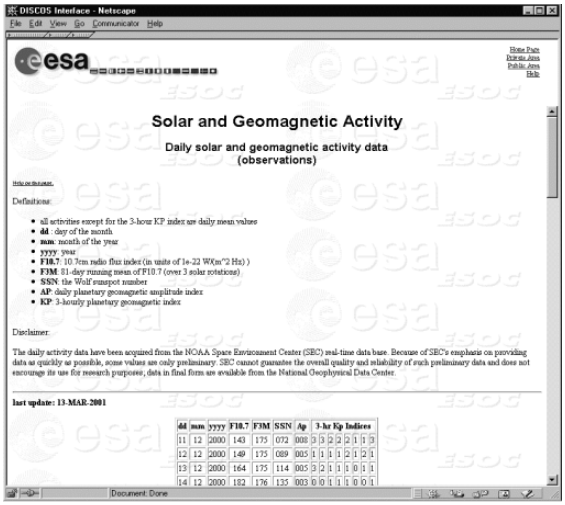


Fig. 5. Daily Solar and Geomagnetic Activity Data (HTML format)

6. CONCLUSIONS

Summarising, DISCOS is a database system containing very useful and complete information on all catalogued objects ever launched into space, as well as other related aspects. It offers users an easy-to-use WWW interface to extract and obtain the desired data, and it also provides and easy-to-use web interface to various tools using DISCOS data as a back-end.

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