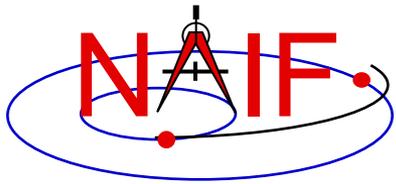


Navigation and Ancillary Information Facility

Obtaining SPICE Products Available from the NAIF and Horizons Servers

Emphasis on Kernels

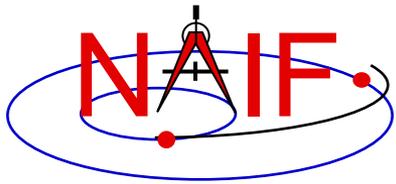
April 2023



Overview

Navigation and Ancillary Information Facility

- **Many SPICE products are available from the NAIF server**
 - These are mostly SPICE products produced at JPL
 - Access is available using the https protocol
 - See the next page for URLs
- **SPICE products made by other organizations are controlled by those organizations**
 - Some may be available from the NAIF server
 - Some may be available at other public servers, or on restricted servers, or not at all
 - » The International Planetary Data Alliance (IPDA) is working towards making large amounts of archived planetary data, including SPICE, universally available through “all” agency archives
 - Unfortunately there is no simple rule set to describe what may be found where
 - As a general rule, NAIF has no cognizance of these products



NAIF Server URLs

Navigation and Ancillary Information Facility

- **NAIF home page**

<https://naif.jpl.nasa.gov>

- Here you may access all official SPICE products produced by NAIF
 - kernels (generic, mission operations, and PDS archived ancillary data)
 - software (Toolkits and individual utility programs)
 - documents
 - tutorials
 - programming lessons
 - problem solving tips
 - rules about using SPICE
 - links to useful resources
 - access to the WebGeocalc tool
 - access to the Cosmographia visualization program

- **SPICE announcements (by NAIF)**

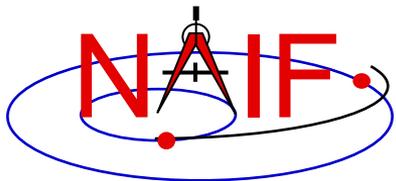
https://naif.jpl.nasa.gov/mailman/listinfo/spice_announce

For use by NAIF staff in making assorted announcements.

- **SPICE discussion (by anyone)**

https://naif.jpl.nasa.gov/mailman/listinfo/spice_discussion

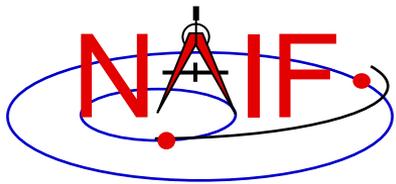
For use by SPICE users who wish to communicate with other SPICE users
(Don't use this if you have questions for NAIF staff)



Getting SPICE Kernels

Navigation and Ancillary Information Facility

- **The remaining charts discuss where to find the various categories of SPICE kernel files**
 - **Operational flight project kernels**
 - » For active flight projects, mostly those at JPL
 - **PDS archived kernels**
 - » Those that have been delivered to and reviewed and accepted by the NAIF Node of NASA's Planetary Data System as part of a formal archive compliant with PDS3 or PDS4 standards
 - » These are the most easily used, due to the existence of furnish kernels (meta-kernels)!
 - » These cover from launch to typically 6-to-9 months behind current time
 - **Generic kernels**
 - » Not tied to any one specific mission
 - » Used by many flight projects and other endeavors
 - » Some of these are also available in the other two categories
 - **How to generate SPKs for comets and asteroids**



Getting Operational Project Kernels - 1

Navigation and Ancillary Information Facility



1 - Select Data

- Home
- Announcements
- Projects
- For the Public
- Data**
- Toolkit

SPICE

An Observation Geometry System for Space Science Missions

Click here for [announcements](#) regarding SPICE data, software, tutorials and



SPICE Data (SPICE Kernels)

- [PDS Archived SPICE Data Sets](#)
- [Operational Flight Project Kernels and Other Non-archived Project Kernels](#)
- [Generic Kernels](#)

As shown above, three categories of SPICE are available from this website. You should categorize using the links below in order to needs.

2 - Select OPS Data



3 - Select the mission class of interest

- Home
- Announcements
- Projects
- For the Public
- Data
- Toolkit
- Utilities
- WebGeocalc
- Cosmographia
- Documentation

Operational Flight Project Kernels and Other Non-archived Project Kernels for Assorted Other Projects

- [Heliophysics Missions](#)
- [Mercury Missions](#)
- [Venus Missions](#)
- [Earth Missions](#)
- [Lunar Missions](#)
- [Mars Missions](#)
- [Outer Planet Missions](#)
- [Comet and Asteroid Missions](#)
- [Astrophysics Missions](#)



- Home
- Announcements
- About SPICE
- About NAIF
- For New Projects
- For the Public
- Data
- Toolkit
- Utilities
- WebGeocalc
- Cosmographia
- Documentation
- Tutorials
- Lessons

The number of files for each SPICE kernel type is shown in the table below for the missions specified. An asterisk (*) indicates that one or more non-kernel files are also present; usually this is an 'aareadme' file that explains the kernel file naming convention. The count of the number of kernels is made ONLY in the primary directory; in sub-directories (for instance, older versions).

4 - Select mission or kernel type

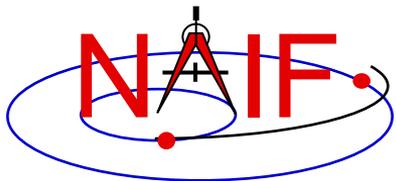
Outer Planet Missions

Mission	ck	ek	fk	ik	lsk	pck	sclk	spk
CASSINI*	6995*	556*	28*	15*	6*	428*	12*	5818*
GALILEO*	26	0		7	2	3	1	11*
JUNO*	1186*		8*	24*	4*	3*	146*	1110*

4a - Select the project name to get access to the kernels folder for that project with sub-folders for all kernel types (see next page)

-OR-

4b - Select the kernel type to get access to all kernels of that type for that project. The number tells how many kernels of that type are available. (see next page)



Getting Operational Project Kernels - 2

Navigation and Ancillary Information Facility

Access to all kernels for the named project

Access to kernels of the selected type for the named project

Name	Last modified	Size
Parent Directory		-
aareadme.txt	2004-03-11 14:39	400
ck/	2019-08-06 11:26	-
ek/	2017-10-18 19:04	-
fk/	2021-11-25 10:51	-
ik/	2019-07-25 12:06	-
lsk/	2016-08-03 03:12	-
pck/	2018-09-22 06:41	-
scl/	2018-05-16 09:04	-
spk/	2020-02-13 09:20	-

Name	Last modified	Size
Parent Directory		-
000202R_SK_LP0_V1P32.bsp		
000202R_SK_LP0_V1P32.bsp.lbl		
000202R_SK_V1P32_V2P12.bsp		
000202R_SK_V1P32_V2P12.bsp.lbl		
000202R_SK_V2P12_EP15.bsp		
000202R_SK_V2P12_EP15.bsp.lbl		
...		

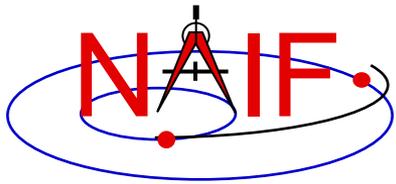
SPK file (binary)

Detached file label (plain text)

Then change to the folder containing the kind of kernels of interest to you, such as SPK.

991130_MASURSKY.bsp		
991130_MASURSKY.bsp.lbl		
aareadme.txt		
de403.bsp		
de403.bsp.lbl		

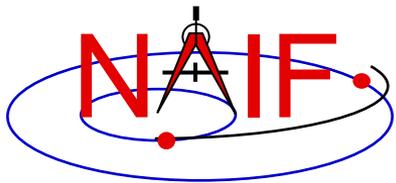
Description of file naming scheme



Getting PDS Archived Kernels - 1

Navigation and Ancillary Information Facility

- **The best method for obtaining PDS archived kernels is directly from the NAIF server.**
 - Complete SPICE data sets exist on the NAIF server fully expanded—not bundled in a Zip or tar file
 - Unless you have reason to do otherwise, download the entire archival data set using the "Archive Link"
 - » That way you'll get all the latest data, the associated "furnsh kernels", and the best documentation.
 - If the data set is large and you need only a portion of it based on start/stop time, use the "subsetter" link to obtain the smaller amount of data needed.
- **Pictorial examples are shown on the next few pages.**



Getting PDS Archived Kernels - 2

Navigation and Ancillary Information Facility



1 – Select Data

- Home
- Announcements
- Projects
- For the Public
- Data**
- Toolkit

SPICE

An Observation Geometry System for Space Science Missions

Click here for [announcements](#) regarding SPICE data, software, tutorials and



SPICE Data (SPICE Kernels)

- **PDS Archived SPICE Data Sets**
- [Operational Flight Project Kernels and Other Non-archived Project Kernels](#)
- [Generic Kernels](#)

As shown above, three categories of SPICE are available from this website. You should categorize using the links below in order to needs.

2 – Select PDS Data



3 - Select PDS archives

- Home
- Announcements
- About SPICE
- About NAIF
- For New Projects
- For the Public
- Data**
- Toolkit

PDS Archived SPICE Data Sets

PDS SPICE Archives

For each mission the kernels and associated descriptive information are provided as a single PDS data set. For a majority of the missions this is an [accumulating](#) PDS data set, initially assembled with archival data from the earliest portion of the mission and then increasing in size as the mission progresses and new "chunks" of archival SPICE data are added, typically every three or six months.



4 – Copy or select archive link

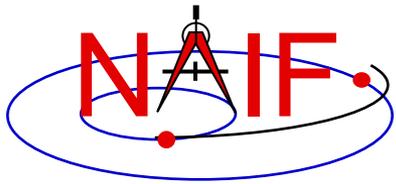
Mission Name	Archive Readme	Archive Link	PDS3 or PDS4	Data Size (GB)	Start Time	Stop Time	Subset Link
Cassini Orbiter	readme	link	3	62.5	1997-10-15	2017-09-15	subset
Clementine	readme	link	3	0.8	1994-01-26	1994-05-07	subset
DART	readme	link	4	9.1	2021-11-09	2050-01-01	subset
DAWN	readme	link	3	86.4	2007-09-27	2018-10-31	subset

4a – Copy link to get the whole archive using "wget"
https://naif.jpl.nasa.gov/pub/naif/pds/data/co-s_j_e_v-spice-6-v1.0/cosp_1000

-OR-

4b - Select archive link to browse archive directory tree and access individual kernels, meta-kernels, and archive documentation (see next pages)





Getting Archived Kernels – PDS3

Navigation and Ancillary Information Facility

Top level directory on a PDS3 SPICE archive

Select "aareadme.htm" to access PDS3 archive description document

Name	Last modified	Size
Parent Directory		-
aareadme.htm	2021-03-31 17:58	10K
aareadme.lbl	2021-03-31 17:58	700
aareadme.txt		
catalog/		
data/		
document/	2009-06-30 13:55	-
errata.txt	2016-01-04 12:42	5.8K
extras/	2007-03-02 17:32	-
index/	2022-12-21 11:19	-
software/	2007-11-24 09:02	-
voldesc.cat	2008-07-28 11:30	2.0K

Select "data" to access kernel-type folders

Name
Parent Directory
ck/
ek/
fk/
lk/
lsk/
pck/
sck/
spk/

Select a kernel-type folder to access kernels

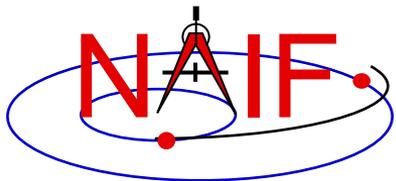
Name
Parent Directory
fkinfo.txt
grail_crashsite_v01.lbl
grail_crashsite_v01.tf
grail_v07.lbl
grail_v07.tf
moon_080317.lbl
moon_080317.tf

Select "extras" to access "mk" folder

Name
Parent Directory
extrinfo.txt
mk/
orbnum/

Select "mk" to access meta-kernels

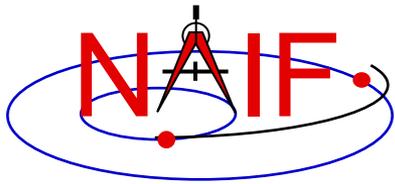
Name
Parent Directory
grail_v01.tm
grail_v02.tm
grail_v03.tm
mkinfo.txt



Getting Archived Kernels – PDS4

Navigation and Ancillary Information Facility





Obtaining Archived Kernels - Subsetter

Navigation and Ancillary Information Facility



Home
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Utilities
WebGeocalc
Cosmographia
Documentation
Tutorials
Lessons
Training
Bugs
Useful Links
Rules

PDS SPICE Archives

Descriptions of the table contents are provided below, after the table.

Mission Name	Archive Readme	Archive Link	PDS3 or PDS4	Data Size (GB)	Start Time	Stop Time	Subset Link
Cassini Orbiter	readme	link	3	62.5	1997-10-15	2017-09-15	subset
Clementine	readme	link	3	0.8	1994-01-26	1994-05-07	subset
DART	readme	link	4	9.1	2021-11-09	2050-01-01	subset
DAWN	readme	link	3	86.4	2007-09-27	2018-10-31	subset
Deep Impact	readme	link	3	0.7	2005-01-12	2005-08-09	subset
Deep Space 1	readme	link	3	0.9	1998-10-24	2001-12-18	subset
EPOXI	readme	link	3	1.0	2005-08-23	2011-03-01	subset
ExoMars TGO 2016	readme	link	4	9.4	2016-03-14	2023-01-01	subset
CPATH	readme	link	3	4.3	2011-09-10	2012-12-17	subset

- Use the **Subsetter** tool to obtain a part of an archive covering a period of interest.
- Specify subset start and stop times in the form
- **Subsetter will:**
 - select just the kernels that fall within or overlap the specified time bounds
 - construct a new meta-kernels containing the names of this subset of kernels (thus making it easy to load the subset into your program)
 - create a custom wget script that can be used to download these files to a user computer
- Run the script to download kernels and adjust path in MK to use them

Select "subset" to obtain a subset of an archive

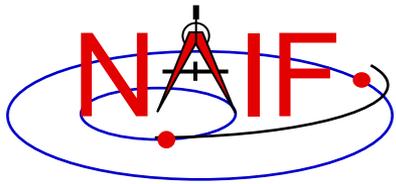
Subsetting DAWN-M/A-SPICE-6-V1.0 SPICE PDS archive

Start: Stop:

Instructions

This service facilitates downloading to and accessing on the user's host a subset of SPICE kernels from the specified SPICE PDS archive covering the specified time interval. It uses the kernel coverage information from the PDS3 index file or PDS4 labels and meta-kernels (also known

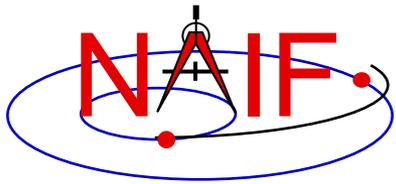
Type in subset start and stop times and click "Subset"



Downloading Archived Kernels – wget

Navigation and Ancillary Information Facility

- **Use GNU's wget or a similar utility to download the complete SPICE data set**
 - **Example using wget on the Deep Impact mission:**
 - » **Open a terminal window**
 - » **wget -m -nH --cut-dirs=5 -nv (insert the URL of the "Archive Link" for the SPICE data set here). For example:**
 - `wget -m -nH --cut-dirs=5 -nv http://naif.jpl.nasa.gov/pub/naif/pds/data/di-c-spice-6-v1.0/disp_1000/`



Getting Generic Kernels

Navigation and Ancillary Information Facility

1 - Select Data

2 - Select Generic Kernels

3 - Select Generic Kernels

4 - Select the kernel type

5 - Select Kernels of Interest

SPICE
An Observation Geometry System for Space Science Missions

SPICE Data (SPICE Kernels)

- PDS Archived SPICE Data Sets
- Operational Flight Project Kernels and Other Non-archived Project Kernels
- Generic Kernels

As shown above, three categories are available from this website. Categories using the links below needs.

Generic Kernels

SPICE kernels that exist independent of any particular flight project are called generic kernels. These may be obtained from the Generic Kernels link of the NAIF server appearing above.

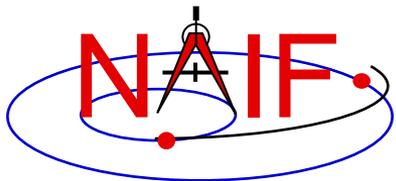
Planetary Data System Navigation Node

Name	Last Modified	Size
Parent Directory		
AACLEARANCE_STATEMENT.pdf	2017-09-28 16:47	49K
aareadme.txt	2018-11-07 11:32	3.6K
dsk/	2017-07-08 04:03	-
fk/	2007-04-02 17:57	-
lsk/	2018-05-29 16:36	-
pck/	2023-03-11 17:07	-
spk/	2022-09-11 08:47	-
stars/	2007-02-15 17:36	-

Name	Last Modified	Size
Parent Directory		
a_old_versions/	2016-07-14 17:00	-
aareadme.txt	2018-05-29 16:44	792
latest_leapseconds.tls	2016-07-14 17:00	5.1K
latest_leapseconds.tls.pc	2016-07-14 17:02	5.3K
naif0011.tls	2016-08-22 22:36	5.0K
naif0012.tls	2016-07-14 17:00	5.1K

Description of folder contents and naming scheme

Latest LSK file



Direct Access to Server Directory Tree

Navigation and Ancillary Information Facility

- Everything publicly available on the NAIF server is also accessible by browsing its directory tree starting at

<https://naif.jpl.nasa.gov/pub/naif>

Name	Last modified	Size
Parent Directory		-
AAREADME	2021-08-29 09:48	1.4K
AA_CLEARANCE_STATEMENT.TXT	2021-08-29 09:57	304
AA_README_EXPORT.TXT	2006-07-11 11:42	365
APOLLO/	2001-07-30 15:49	-
BEPICOLOMBO/	2023-03-12 04:50	-
CASSINI/	2003-01-16 15:54	-
...		
VOYAGER/	2021-09-03 16:47	-
cosmographia/	2022-12-29 06:25	-
deprecated_kernels/	2011-02-18 01:36	-
generic_kernels/	2017-09-28 16:47	-
misc/	2022-12-30 08:25	-
pds/	2020-12-21 07:43	-
self_training/	2013-12-30 14:06	-
toolkit/	2022-02-04 07:30	-
toolkit_docs/	2022-10-18 12:04	-
utilities/	2022-01-03 13:04	-

Operational and past project kernel directories

Generic kernels

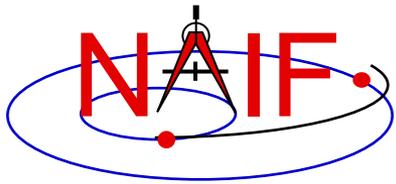
PDS archives and generic WebGeocalc kernel sets

Toolkit documentation, Tutorials and Lessons

Cosmographia packages and additional materials

Toolkit packages

Toolkit utilities



Horizons

Navigation and Ancillary Information Facility

- **The Horizons server is an on-line ephemeris generator for natural bodies (and more)**
 - It is operated by JPL's Solar System Dynamics Group, not by NAIF
- **Of primary interest to SPICE users is its ability to generate up-to-date SPK files for comets and asteroids**
 - Horizons home page:
 - » <https://ssd.jpl.nasa.gov/horizons/>
 - Horizons web interface for manual generation of small body SPKs:
 - » <https://ssd.jpl.nasa.gov/horizons/app.html#/>
 - Horizons telnet interface for automated (programmatic) generation of small body SPKs:
 - » `telnet ssd.jpl.nasa.gov 6775`
 - » For an example script, use anonymous ftp to go to:
 - `ssd.jpl.nasa.gov`
 - » and once there, look at `pub/ssd/SCRIPTS/smb_spk`