SPICE in ESA Datalabs

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ESA SPICE Service

Datalabs Workshop
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SPICE in a nutshell

SPICE is an information system that uses *ancillary data* to provide Solar System geometry information to scientists and engineers for planetary missions in order to plan and analyze scientific observations from space-born instruments. SPICE was originally developed and maintained by the Navigation and Ancillary Information Facility (NAIF) team of the Jet Propulsion Laboratory (NASA).

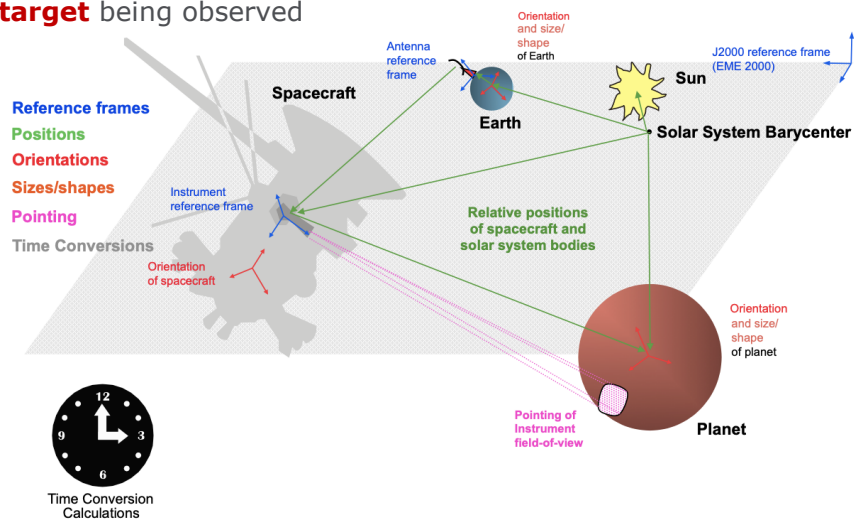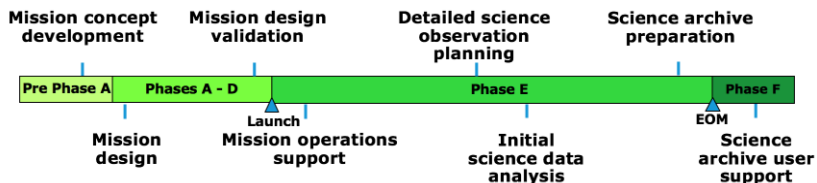"Ancillary data" are those that help scientists and engineers determine:

- where the **spacecraft** was **located**
- how the spacecraft and its instruments were **oriented** (pointed)
- what was the **location, size, shape and orientation of the target** being observed
- what **events were occurring** on the spacecraft

➢ SPICE provides users a large suite of SW used to read SPICE ancillary data files to compute observation geometry.

➢ The ancillary data (kernels) comes from: The S/C, MOC/SGS, S/C manufacturer and Instrument teams, Science Organizations.

Reference frames — Positions — Orientations — Sizes/shapes — Pointing — Time Conversions

Spacecraft · Antenna reference frame · Orientation and size/shape of Earth · Earth · Sun · J2000 reference frame (EME 2000) · Solar System Barycenter · Instrument reference frame · Relative positions of spacecraft and solar system bodies · Orientation of spacecraft · Orientation and size/shape of planet · Pointing of Instrument field-of-view · Planet

Time Conversion Calculations

Mission concept development · Mission design validation · Detailed science observation planning · Science archive preparation

Pre Phase A · Phases A - D · Phase E · Phase F

Launch · EOM

Mission design · Mission operations support · Initial science data analysis · Science archive user support

SPICE in ESA Datalabs

➤ ESA datalabs offers a catalog of datalabs you can use, and all are accessible via your web browser.

- SPICE dedicated Datalab will be made available

➤ Once a Datalab has been launched, Data Volumes can be mounted.

➤ The SPICE Data Volume (all content available at spiftp) is already available to be mounted in Datalabs

Data Volume Settings

Name: SPICE

Path in datalab: /media/data/ spice

Data source URL: Please fill at least the "Connection type" and "Server" fields below
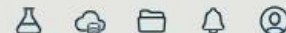
Connection type: nfs

Server: netapp3.evsp.lan

Port:

Path: /mex_spiftp01

✓ UPDATE   ✕ CANCEL

European Space Agency

ESA Datalabs [0.3.0/BETA]

File   Edit   View   Run   Kernel   Git   Tabs   Settings   Help

Filter files by name

/

Name	Last Modified
data	7 months ago
MEX-TGO	2 months ago
Mutual_Ra...	2 months ago
my_works...	7 months ago
em16_ops...	2 months ago
Mars_Vikin...	9 years ago
MEX_OPS...	2 months ago
mex-vmc.i...	2 months ago
notebooks	7 months ago
VMC_SR_...	7 months ago

mex-vmc.ipynb   mex-tgo.ipynb   OccultationGeometryOutpu

Markdown   git   Python 3 (ipykernel)

SPICE for Mars Express VMC Tutorial

This Notebook aims for showing some of the SPICE applications to compute geometry for a planetary mission. In this tutorial, we will focus on the geometry of VMC (Visual Monitoring Camera) onboard Mars Express.

Loading the SPICE Data Volume

In order to load the SPICE Data Volume into this ESA Datalab, the SPICE Volume has to be configured first. To do so, go to Data Volumes at the ESA Datalabs toolbar and introduce the following configuration:

- **Name**: SPICE
- **Path in datalab**: /media/data/spice
- **Connection type**: nfs
- **Server**: netapp3.evsp.lan
- **Path**: /mex_spiftp01

Once, the SPICE Volume has been configured, go back to the Datalab and select the SPICE Volume in the toolbar at the top right.

Loading the SPICE Kernel Dataset

Simple   2   S   0   ⚙   Python 3 (ipykernel) | Idle   Mode: Command   Ln 1, Col 1   mex-vmc.ipynb

ESA Datalabs [0.3.0/BETA]

File   Edit   View   Run   Kernel   Git   Tabs   Settings   Help

mex-vmc.ipynb   mex-tgo.ipynb   OccultationGeometryOutpu

Markdown   git   Python 3 (ipykernel)

```python
        phase_matrix[i,j] = np.pi
        solar_matrix[i,j] = np.pi/2
```

```python
[*]:    #
        # We transform the matrix from illumination angles to greyscale [0–255]
        #
        rescaled = (255 / (solar_matrix.max()-solar_matrix.min()) * (solar_matrix - solar_matrix.min())).astype(np
        rescaled = - np.flip(rescaled, 0) + 255

        plt.subplot(1, 2, 1)
        plt.imshow(rescaled, cmap='gray')
        plt.subplot(1, 2, 2)
        im = plt.imread('/media/home/VMC_SR_201230_021410_006.PNG')
        im = plt.imshow(im, extent=[0, nx, 0, ny])
        plt.show()
```

Computing Spacecraft Attitude

In addition to spacecraft position, the orientation of the spacecraft and its components can be as well computed with SPICE. The function for obtaining the transformation between two reference frames is *pxform*, which provides the corresponding rotation matrix.

This matrix can then be converted to quaternions or Euler Angles with *m2q* and *m2eul* respectively.

```python
[15]:   euler_angles = []
```

Filter files by name

/

Name	Last Modified
data	7 months ago
MEX-TGO	2 months ago
Mutual_Ra...	2 months ago
my_works...	7 months ago
em16_ops...	2 months ago
Mars_Vikin...	9 years ago
MEX_OPS...	2 months ago
mex-vmc.i...	seconds ago
notebooks	7 months ago
VMC_SR_...	7 months ago

Simple   2   0   Python 3 (ipykernel) | Busy   Mode: Command   Ln 1, Col 1   mex-vmc.ipynb
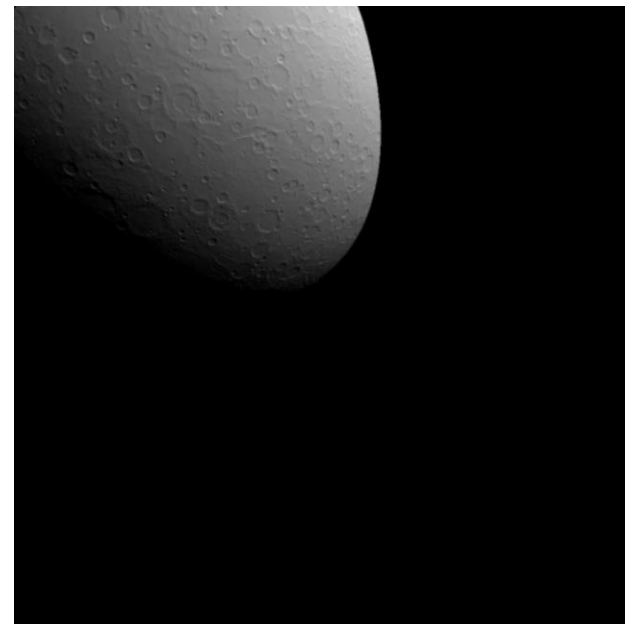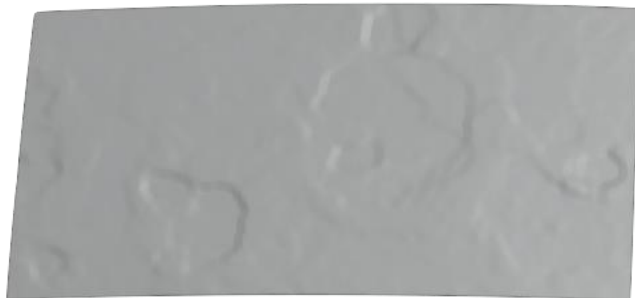
Using SPICE – Tiled DSKs

- ➢ Generated high-resolution tiled global DSK for **Mercury** based on Messenger 665m/px global DEM, for **Mars** based on MOLA 463m/px global DEM, and for the Moon based on LOLA 118m/px global DEM.

- ➢ Available at the esa_generic SKD in spiftp (not included in BitBucket due to large size)

  - • https://spiftp.esac.esa.int/data/SPICE/esa_generic/kernels/dsk/tiled/

Index of /data/SPICE/esa_generic/kernels/dsk/tiled

Name	Last modified	Size	Description
Parent Directory		-	
mars_mola_463m/	2022-03-10 13:54	-	
mercury_messenger_665m/	2022-03-10 18:59	-	
moon_lola_118m/	2022-07-16 10:44	-	

European Space Agency

ESA Datalabs [0.3.0/BETA]

File   Edit   View   Run   Kernel   Git   Tabs   Settings   Help

mex-vmc.ipynb   mex-tgo.ipynb   OccultationGeometryOutput

Markdown   git   Python 3 (ipykernel)

Filter files by name

/

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Mutual_Ra...	2 months ago
my_works...	7 months ago
em16_ops...	2 months ago
Mars_Vikin...	9 years ago
MEX_OPS...	2 months ago
mex-vmc.i...	a minute ago
notebooks	7 months ago
VMC_SR_...	7 months ago

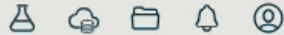# SPICE for Mars Express - TGO mutual occultation observations Tutorial

This Notebook aims for showing some of the SPICE applications to compute geometry for a planetary mission. In this tutorial, we will focus on the mutual radio-occultation observations performed by Mars-Express (MEX) and the Trace Gas Orbiter (TGO).

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- **Server**: netapp3.evsp.lan
- **Path**: /mex_spiftp01

Once, the SPICE Volume has been configured, go back to the Datalab and select the SPICE Volume in the toolbar at the top right.

Simple   2   0   Python 3 (ipykernel) | Idle   Mode: Command   Ln 1, Col 1   mex-tgo.ipynb

ESA Datalabs [0.3.0/BETA]

File   Edit   View   Run   Kernel   Git   Tabs   Settings   Help

mex-vmc.ipynb   OccultationGeometryOutpu

Delimiter: [, ▾]

		DoY	Date	StartUTC	OccUTC	EndUTC
1	'02/04/2021 15:09:00 ...	092	'02/04/2021	15:09:00	15:18:16	15:19:00
2	'06/04/2021 03:30:00 ...	096	'06/04/2021	03:30:00	03:38:49	03:40:00
3	'14/04/2021 23:32:00 ...	104	'14/04/2021	23:32:00	23:33:09	23:42:00
4	'18/05/2021 07:07:00 ...	138	'18/05/2021	07:07:00	07:08:32	07:17:00
5	'25/05/2021 00:08:00 ...	145	'25/05/2021	00:08:00	00:09:05	00:18:00
6	'11/07/2021 17:01:00 ...	192	'11/07/2021	17:01:00	17:01:28	17:11:00
7	'11/07/2022 15:13:38 ...	192	'11/07/2022	15:13:38	15:14:30	15:23:38
8	'19/07/2022 19:49:30 ...	200	'19/07/2022	19:49:30	19:58:45	19:59:30
9	'29/07/2022 02:16:00 ...	210	'29/07/2022	02:16:00	02:24:44	02:26:00

/ MEX-TGO /

Name	Last Modified
em16_ops...	12 minutes ago
inputFile.txt	2 months ago
MEX_OPS...	12 minutes ago
mex-tgo.ip...	10 minutes ago
Occultatio...	2 months ago
Occultatio...	2 months ago

Filter files by name

Simple ⬤   2 $ 0 ⏰ ⬦   OccultationGeometryOutput.csv

ESA Datalabs [0.3.0/BETA]

Create Datalab

Find a datalab in ESA datalabs catalog

Filter results

aladin

Aladin is an interactive sky atlas allowing the user to visualize digitized astronomical images or full surveys, superimpose entries from astronomical catalogues or databases, and interactively access related data and information from the *Simbad database*, the *VizieR* service and other archives for all known astronomical objects in the field.

filezilla

FileZilla

fv

FV - An image display and visualization tool for astronomical data

jl-esdc

Jupyterlab ESDC

jl-euclid-dps

Euclid DPS JupyterLab

jl-herschel

Herschel JupyterLab

jl-juice

JupyterLab with JUICE moon coverage tool (0.8.0).

jl-pangaia

PanGaia JupyterLab

Keeping in touch

https://github.com/esaSPICEservice

ESA SPICE Service
@SpiceEsa

Tweets	Following	Followers
39	72	85

https://twitter.com/SpiceEsa

https://tinyurl.com/y77bxntk

COMMUNICATE

➢ Everything is accessible from: **http://spice.esac.esa.int**

➢ Contact the service via e-mail **spice@sciops.esa.int**

➢ Stay tuned. You can join one of the mission-specific mailing list: **spice_mex@sciops.esa.int**

➢ You can also join the OpenPlanetary Slack channel: **http://openplanetary.org**

COLLABORATE

➢ If you are a SPICE Kernel producer or a bi-product of your investigations are Ancillary Data (Reconstructed Trajectory, S/C Orientation, Natural Body Ephemeris) please contact us and share your data with the community.

European Space Agency