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# **Matlab Interface to CSPICE “Mice”**

## **How to Access the CSPICE library Using Matlab<sup>©</sup>**

### **September 2009**



# Topics

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- **Mice Benefits**
- **How does it work?**
- **Distribution**
- **Mice Operation**
- **Vectorization**
- **Simple Mice Example**

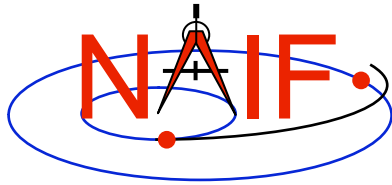


# Mice Benefits

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- **Mice operates as an extension to the Matlab environment.**
- **All Mice calls are functions regardless of the call format of the underlying CSPICE routine, returning Matlab native data types.**
- **Mice has some capability not available in CSPICE such as vectorization.**
- **CSPICE error messages return to Matlab in the form usable by the *try...catch* construct.**



# How Does It Work? (1)

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- **The Matlab environment includes an intrinsic capability to use external routines.**
  - **Mice functions as a Matlab Executable, MEX, consisting of the Mice MEX shared object library and a set of .m wrapper files.**
    - » **The Mice library contains the Matlab callable C interface routines that wrap a subset of CSPICE wrapper calls.**
    - » **The wrapper files, named `cspice_*.m` and `mice_*.m`, provide the Matlab calls to the interface functions.**
      - » **A function prefixed with ‘`cspice_`’ retains essentially the same argument list as the CSPICE counterpart.**
      - » **An interface prefixed with ‘`mice_`’ returns a structure, with the fields of the structure corresponding to the output arguments of the CSPICE counterpart.**
    - » **The wrappers include a header section describing the function call, displayable by the Matlab *help* command.**



## How Does It Work? (2)

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**When a user invokes a call to a Mice function:**

- 1. Matlab calls...**
- 2. the function's wrapper, which calls...**
- 3. the Mice MEX shared object library, which performs its function then returns the result...**
- 4. to the wrapper, which...**
- 5. returns the result to the user**

**... transparent from the user's perspective.**



# Mice Distribution

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- **NAIF distributes Mice as a complete, standalone package.**
- **The package includes:**
  - the CSPICE source files
  - the Mice interface source code
  - platform specific build scripts for Mice and CSPICE
  - Matlab versions of the SPICE cookbook programs, *states*, *tictoc*, *subpt*, and *simple*
  - an HTML based help system for both Mice and CSPICE, with the Mice help cross-linked to CSPICE
  - the Mice MEX shared library and the M wrapper files. The system is ready for use after installation of the the library and wrapper files.
- **Note: You do not need a C compiler to use Mice.**



# Mice Operation (1)

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- **A possible irritant exists in loading kernels using the `cspice_furnsh` function.**
  - **Kernels load into your Matlab session, not into your Matlab scripts. This means:**
    - » loaded binary kernels remain accessible (“active”) throughout your Matlab session
    - » data from loaded text kernels remain in the kernel pool (in the memory space used by CSPICE) throughout your Matlab session
  - **Consequence: some kernel data may be available to one of your scripts even though not intended to be so.**
    - » You could get **incorrect results!**
    - » If you run only one script during your Matlab session, there’s no problem.



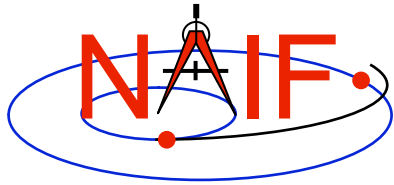
## Mice Operation (2)

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- **Mitigation: two approaches**
  - **Load all needed SPICE kernels for your Matlab session at the beginning of the session, paying careful attention to the files loaded and the loading order (loading order affects precedence)**
    - » **Convince yourself that this approach will provide ALL of the scripts you will run during this Matlab session with the appropriate SPICE data**
  - **At or near the end of every Matlab script:**
    - » **include a call to `cspice_unload` for each kernel loaded using `cspice_furnsh`**
    - » **or include a call to `cspice_kclear` to remove ALL kernel data from the kernel pool loaded using `cspice_furnsh`**





# Mice Vectorization (1)

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- **Most Mice functions include use of vectorized arguments, a capability not available in C or Fortran toolkits.**
- **Example: use Mice to retrieve state vectors and light-time values for 1000 ephemeris times.**
  - **Create the array of 1000 ephemeris times in steps of 10 hours, keyed on July 1, 2005:**

```
start = cspice_str2et('July 1 2005');  
et     = (0:999)*36000 + start;
```

- **Retrieve the state vectors and corresponding light times from Mars to earth at each `et` in the J2000 frame with LT+S aberration correction:**

```
[state, ltime] = cspice_spkezr( 'Earth', et, 'J2000', 'LT+S', 'MARS');  
or  
starg = mice_spkezr( 'Earth', et, 'J2000', 'LT+S', 'MARS');
```



## Mice Vectorization (2)

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- Access the *ith* state 6-vector (6x1 array) corresponding to the *ith* ephemeris time with the expression

```
state_i = state(:,i)
```

or

```
state_i = starg(i).state
```

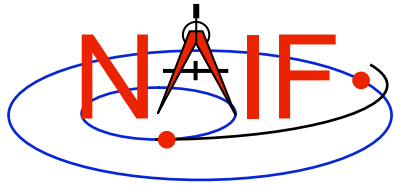
- Convert the ephemeris time vector *et* from the previous example to UTC calendar strings with three decimal places of precision in the seconds field.

```
format = 'C';
```

```
prec    = 3;
```

```
utcstr = cspice_et2utc( et, format, prec );
```

- The call returns *utcstr*, an array of 1000 strings (dimensioned 1000x24), where each *ith* string is the calendar date corresponding to *et(i)*.



## Mice Vectorization (3)

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- Access the *ith* string of `utcstr` corresponding to the *ith* ephemeris time with the expression

```
utcstr_i = utcstr(i,:)
```

- Convert the position components (the first three components in a state vector) of the *N* state vectors returned in `state` by the `cspice_spkezr` function to latitudinal coordinates.

```
[radius, latitude, longitude] = cspice_reclat( state(1:3,:) );
```

- The call returns three double precision 1x1000 arrays (vectorized scalars): `radius`, `latitude`, `longitude`.



# Simple Mice Example (1)

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- **As an example of Mice use, calculate and plot the trajectory in the J2000 inertial frame of the Cassini spacecraft from June 20, 2004 to December 1, 2005. This example uses the `cspice_spkpos` function to retrieve position data.**

```
% Define the number of divisions of the time interval and the time interval.
STEP = 1000;

% Load the needed kernels. Use a meta kernel "standard.ker" to load the kernels
% "naif0009.tls," "de405_2000-2050.bsp," "pck00008.tpc."

cspice_furnsh( { 'standard.tm', '/kernels/cassini/spk/T18-5TDJ5.bsp' } )

et          = cspice_str2et( {'Jun 20, 2004', 'Dec 1, 2005'} );
times       = (0:STEP-1) * ( et(2) - et(1) )/STEP + et(1);

[pos,ltime]= cspice_spkpos( 'Cassini', times, 'J2000', 'NONE', 'SATURN BARYCENTER' );

% Plot the resulting trajectory.
x = pos(1,:);
y = pos(2,:);
z = pos(3,:);

plot3(x,y,z)

cspice_kclear
```

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# Simple Mice Example (2)

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- The example script using the `mice_spkezt` function.

```
% Define the number of divisions of the time interval and the time interval.
STEP = 1000;

% Load the needed kernels. Use a meta kernel "standard.ker" to load the kernels
% "naif0000.tls," "de405_2000-2050.bsp," "pck00008.tpc."

cspice_furnsh( { 'standard.tm', '/kernels/cassini/spk/T18-5TDJ5.bsp' } )

et    = cspice_str2et( {'Jun 20, 2004', 'Dec 1, 2005'} );
times = (0:STEP-1) * ( et(2) - et(1) )/STEP + et(1);

ptarg = mice_spkpos( 'Cassini', times, 'J2000', 'NONE', 'SATURN BARYCENTER' );
pos    = [ptarg.pos];

% Plot the resulting trajectory.
x = pos(1,:);
y = pos(2,:);
z = pos(3,:);

plot3(x,y,z)

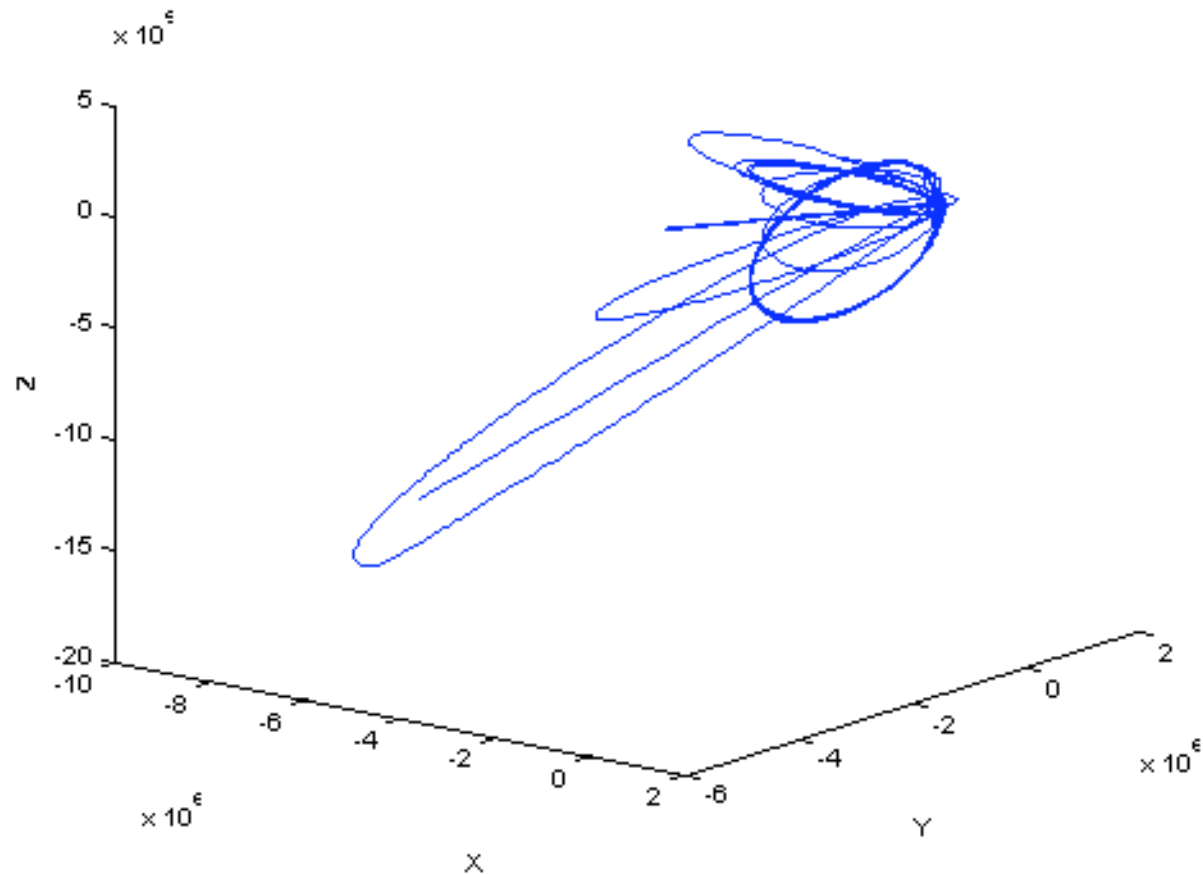
cspice_kclear
```

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# Mice Example Graphic Output

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**Trajectory of the Cassini vehicle in the J2000 frame, for June 20, 2004 to Dec 1, 2005**