



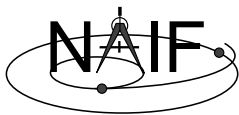
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IDL Interface to CSPICE “Icy”

**How to Access the CSPICE library Using
Interactive Data Language (IDL)®**

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Topics

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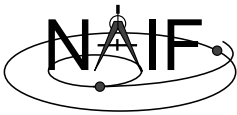
- **Icy Benefits**
- **How does it work?**
- **Distribution**
- **Icy Operation**
- **Vectorization**
- **Simple Use of Icy Functionality**



Icy Benefits

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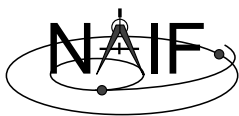
- **Ease of use:** Icy operates as an extension to the IDL language regime.
- Icy supports more than three-hundred CSPICE routines.
- Icy calls usually correspond to the call format of the underlying CSPICE routine, returning IDL native data types.
- Icy has some capability not available in CSPICE such as vectorization.
- CSPICE error messages return to IDL in the form usable by the *catch* error handler construct.



How Does It Work? (1)

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- **The IDL environment includes an intrinsic capability to use external routines.**
 - Icy functions as an IDL Dynamically Loadable Module (DLM). A DLM consists of a shared object library (*icy.so/.dll*) and a DLM text definition file (*icy.dlm*).
 - » The shared library contains a set of IDL callable C interface routines that wrap a subset of CSPICE wrapper calls.
 - » The text definition file lists the routines within the shared library and the format for the routine's call parameters.



How Does It Work? (2)

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- **Using icy from IDL requires you register the icy DLM with IDL to access the interface routines. Several means exist to do so:**
 - on Unix/Linux, start IDL from the directory containing icy.dlm and icy.so
 - from the IDL interpreter (or from a command script), execute the `dml_register` command, e.g.
 - » `IDL> dml_register, '/naif/icy/lib/icy.dlm'`
 - » `IDL> dml_register, 'c:\naif\icy\lib\icy.dlm'`
 - copy icy.dlm and icy.so (icy.dll) to IDL's binary directory {The IDL install directory}\bin\bin.<your_arch>, e.g.
 - » `/usr/local/rsi/idl_6.3/bin/bin.darwin.ppc/`
 - » `D:\RSI\IDL63\bin\bin.x86\`
 - set the `IDL_DLM_PATH` environment variable to a directory containing icy.dlm and icy.so (icy.dll)



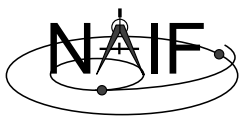
How Does It Work? (3)

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When a user invokes a call to a DLM routine:

1. IDL calls...
2. the interface routine in the shared object library, linked against...
3. CSPICE, which performs its function and returns the result...
4. to IDL...

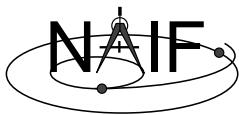
... transparent from the user's perspective.



Icy Distribution

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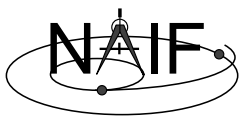
- **NAIF distributes the Icy package as an independent product analogous to SPICELIB and CSPICE.**
- **The package includes:**
 - the CSPICE source files
 - the Icy interface source code
 - platform specific build scripts for Icy and CSPICE
 - IDL versions of the SPICE cookbook programs, *states*, *tictoc*, *subpt*, and *simple*
 - an HTML based help system for both Icy and CSPICE, with the Icy help cross-linked to CSPICE
 - the Icy shared library and DLM file. The system is ready for use after installation of the these files



Icy Operation (1)

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- **A user may occasionally encounter an IDL math exception:**
`% Program caused arithmetic error: Floating underflow`
 - This warning occurs most often as a consequence of CSPICE math operations.
- **In all known cases, the SIGFPE exceptions caused by CSPICE can be ignored. CSPICE assumes numeric underflow as zero.**
 - A user can adjust IDL's response to math exceptions by setting to the `!EXCEPT` variable:
 - » `!EXCEPT = 0` suppresses the SIGFPE messages.
 - » `!EXCEPT = 1` the default, reports math exceptions on return to the interactive prompt.
 - » `!EXCEPT = 2` reports exceptions immediately after executing the command.



Icy Operation (2)

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- A possible irritant exists in loading kernels using the `cspice_furnsh` function.
 - Kernels are loaded into your IDL session, not into your IDL scripts. This means:
 - » loaded binary kernels remain accessible (“active”) throughout your IDL session
 - » data from loaded text kernels remain in the kernel pool (in the IDL memory space) throughout your IDL 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 IDL session, there’s no problem.)



Icy Operation (3)

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- Mitigation: two approaches
 - Load all needed SPICE kernels for your IDL 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 IDL session with the appropriate SPICE data
 - At or near the end of every IDL script you write:
 - » provide a call to `cspice_unload` for each kernel loaded using `cspice_furnsh`
 - » provide a call to `cspice_kclear` to remove ALL kernel data from the kernel pool



Icy Vectorization (1)

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- Several common icy functions include use of vectorized arguments, a capability not available in C or FORTRAN toolkits.
- Example: use icy to retrieve state vectors and light-time values for 1000 ephemeris times.
 - Create an array of 1000 ephemeris times with step size of 10 hours, starting from July 1, 2005.

```
cspice_str2et, 'July 1, 2005', start  
et = dindgen( 1000 ) * 36000.d + start
```

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

```
cspice_spekr, 'Earth', et, 'J2000', 'LT+S', 'MARS', state, ltime
```



Icy Vectorization (2)

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- Access the *ith* state 6-vector corresponding to the *ith* ephemeris time with the expression

```
state_i = state[*,i]
```

- Convert the ephemeris time vector `et` from the previous example to UTC calendar strings with three decimal places accuracy.

```
format = 'C'  
prec   = 3  
cspice_et2utc, et, format, prec, utcstr
```

- The call returns `utcstr`, an array of 1000 strings each *ith* string the calendar date corresponding to `et[i]`. Access the *ith* string of `utcstr` corresponding to the *ith* ephemeris time with the expression

```
utcstr_i = utcstr[i]
```



Icy Vectorization (3)

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- **Convert the position components of the N state vectors to latitudinal coordinates (the first three components of a state vector - IDL uses a zero based vector index).**

```
cspice_reclat, state[0:2,*], radius, latitude, longitude
```

- **The call returns three double precision variables of type Array[1000]:**

```
» radius  
» latitude  
» longitude
```

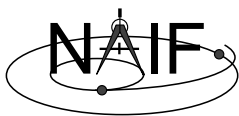


Simple Use of Icy Functionality

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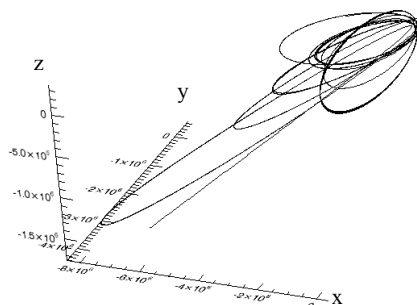
- **As an example of icy use and vectorization, calculate and plot the trajectory in the J2000 inertial frame of the Cassini spacecraft from June 20, 2004 to December 1, 2005.**

```
;; Define the number of divisions of the time interval and the time interval.  
STEP = 10000  
utc = [ 'Jun 20, 2004', 'Dec 1, 2005' ]  
  
;; Load the needed kernels  
cspice_furnsh, 'standard.ker'  
cspice_furnsh, '/kernels/cassini/spk/T18-5TDJ5.bsp'  
  
cspice_str2et, utc, et  
times = dindgen(STEP)*(et[1]-et[0])/STEP + et[0]  
cspice_spkpos, 'Cassini', times, 'J2000', 'NONE', 'SATURN BARYCENTER', pos, ltime  
  
;; Plot the resulting trajectory.  
x = pos[0,*]  
y = pos[1,*]  
z = pos[2,*]  
iplot, x, y, z  
  
cspice_kclear
```



Graphic Output using IDL iTool

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