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Notes on the C programs used to calculate the Ephemerides

For the calculation of the nautical almanac tables, I basically use the "DE405" ephemerides data published by the [Jet Propulsion Laboratory](#) and the C version of the "NOVAS" software package available from the [U.S. Naval Observatory](#).

NOVAS

The Naval **O**bservatory **V**ector **A**strometry **S**ubroutines, **NOVAS**, is an integrated package of source-code modules for computing a wide variety of common astrometric quantities and transformations. Up to now (June 2012), I have been using version 2.0 of this package. The current version is 3.1, but due to the recent introduction of new reference systems, it is not fully "compatible" with the previous version.

The packages can provide, the precise celestial position (apparent, topocentric or astrometric) of selected celestial objects (Sun, Moon, planets, stars, ...) at specified dates and times. At a lower level, NOVAS also provides general astrometric utility transformations, such as those for precession, nutation, aberration, parallax, and the gravitational deflection of light.

The computations are highly precise. The United States Nautical Almanac Office uses NOVAS in the production of its sections of *The Astronomical Almanac*.

NOVAS-C uses, as input, astrometric reference data that is expressed in the International Astronomical Union (IAU) J2000.0 system. In particular, NOVAS-C supports data that conforms to the International Celestial Reference System (ICRS), adopted by the IAU in 1996. ICRS-compatible data includes the Hipparcos and Tycho Catalogues, the ACT Reference Catalogue, the International Celestial Reference Frame (ICRF), **the Jet**



expanding. NOVAS-C can also be used with data conforming to the FK5 system.

Effective use of NOVAS-C requires some background in positional astronomy and some degree of programming experience. It is highly recommended to read the accompanying documentation before attempting to use the software package.

Basic Ephemerides "DE405"

The basic ephemerides I used, are taken from the "DE405" ephemerides files published by the [Jet Propulsion Laboratory](#).

The "NOVAS" package (see above) comes with a Fortran subroutine "jplint.f", which should be able to read the DE405 ephemerides and interface with the C routines of the "NOVAS" software package. However, I found it difficult to link Fortran code and C code together into a working project. Therefore, I wrote my own C version of the "jplint.f" code as a direct interface to the binary "DE405" ephemerides files.

The basic "DE405" [Ephemerides in ASCII format from 1600AD until 2200AD](#) can be downloaded in different files from the JPL server. These "DE405" ephemerides are available in ASCII format, but have to be converted and merged together in one binary file to make it usable for the "jplint" routines. For generating this binary ephemerides file I used the [software package of David Hoffman](#) which is also written in C.

The following lines describe how I generated my binary ephemerides file for the time span 2000 to 2040 using the "convert" and "append" programs of David Hoffman:

- I downloaded the files "ascp2000.405", "ascp2020.405" and "header.405" from the [JPL server](#).
- Then I converted both ASCII files into a corresponding binary file

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```
% convert header.405 ascp2020.405 ascp2020.bin
```

- Finally, I merged the binary files and renamed the resulting binary ephemerides file:

```
% append ascp2000.bin ascp2020.bin
% mv ascp2000.bin JPLephemDE405.bin
% rm ascp2020.bin
```

The resulting binary file "JPLephemDE405.bin" can be read with my version of "jplint.c" and contains the Tchebychev coefficients for the time span 2000 to 2040.

Source Codes, Compiler and Platform Configuration

The complete software package I am using - excluding the "DE405" ephemerides - is available as packed repository. The package ([CN_code.tgz](#)) consists of:

- the NOVAS subroutines (package version 2.0)
- the program codes of David Hoffman for generating and manipulating the binary ephemerides file(s)
- my own source codes for generating the Nautical Almanac and related manuals

and comes as a "gzipped-tar-archive" (approx. 850 Kbyte).

It also contains the C sources for generating the PostScript files of the Sight Reduction Tables, Sextant Correction Tables and Interpolation Tables.

Under Linux/Unix, unzip and unpack the package file with the following procedure:



Or if you have a "gnu" version of "tar" installed it can do both jobs with:

```
% tar -xvzf CN_code.tgz
```

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