

ALMANAC SERVICES FOR CELESTIAL NAVIGATION

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ABSTRACT. Celestial navigation remains a vitally important back up to Global Navigation Satellite Systems (GNSS) and relies on the use of almanac services. HM Nautical Almanac Office (HMNAO) provides a number of these services. The printed book, *The Nautical Almanac*, produced yearly and now available as an electronic publication, is continuously being improved, making use of the latest ideas and ephemerides to provide the user with their required data.

HMNAO also produces *NavPac*, a software package that assists the user in calculating their position as well as providing additional navigational and astronomical tools. A new version of *NavPac* will be released in 2015 that will improve the user experience. The development of applications for mobile devices is also being considered.

HMNAO continues to combine the latest improvements and theories of astrometry with the creation of books and software that best meet the needs of celestial navigation users.

1. PUBLICATIONS AND SOFTWARE

HMNAO produces a variety of publications and software and a number of these provide almanac services for use in assisting celestial navigation:

- The traditional printed book, *The Nautical Almanac*, published yearly, provides the ultimate backup for determining position at sea in the case of GNSS failure. It contains tabulations of the Sun, Moon, navigational planets and stars as well as the other necessary tables, diagrams, forms and information for celestial navigation. These include interpolation and altitude correction tables, pole star tables, diagrams and notes for the identification of stars and planets and information on standard times around the world. A concise set of sight reduction tables and a sight reduction form are also included and allow *The Nautical Almanac* to be used as a stand alone book for celestial navigation calculations.
- The recently introduced electronic version of *The Nautical Almanac*, containing identical data, tables, diagrams, forms and information to the printed book, allows for increased ease of use, distribution and portability.
- The software package, *NavPac*, provides the user with a means for automatically carrying out all the calculations necessary for celestial navigation as well as providing a number of additional navigational and astronomical tools. The automation provided saves time and reduces human errors.
- *Compact Data*, a printed book, accompanies *NavPac* and provides navigators and astronomers with simple and efficient methods for calculating the positions of the Sun, Moon, navigational planets and stars over several years to a consistent precision with the aid of a pocket calculator, personal computer or laptop.
- Other celestial navigation products include *Rapid Sight Reduction Tables for Navigation*, providing the altitude and azimuth for a range of declinations as well as of the seven stars most suitable for finding your position with a sextant.
- Looking ahead, the development of applications for mobile devices to assist the user with celestial navigation is also being considered, providing yet another alternative.

2. COLLABORATION WITH USNO

The Nautical Almanac, and its electronic version, are produced in collaboration with the Astronomical Applications Department at the United States Naval Observatory. The combined expertise at the two offices provides further assurance of the accuracy of the data and information.

3. EPHEMERIDES AND IAU RESOLUTIONS

The current edition of *The Nautical Almanac* and its electronic version, as well as the upcoming new release of *NavPac and Compact Data*, are all based on the DE430/LE430 ephemerides provided by the Jet Propulsion Laboratory and all include the latest IAU resolutions, keeping the data in line with the latest improvements and theories of astrometry. In particular the 2012 IAU resolution regarding the redefinition of the astronomical unit is applied throughout these publications and the 2000 and 2006 IAU resolutions concerning nutation and precession are implemented through the use of the latest IAU SOFA software collection.

4. IMPROVED USER INTERFACE FOR NAVPAC

An updated version of the celestial navigation software package produced by HMNAO, *NavPac*, is due to be released in early 2015. This version will incorporate a new interface that will provide an improved user experience making the software easier and more intuitive to use while still retaining all the current features and tools.

5. ADDITIONAL TOOLS WITHIN NAVPAC

The NavPac software, as well as providing an automated version of the calculations that a navigator would carry out using data from *The Nautical Almanac*, provides additional tools. These include a FindIt application that allows for easy planning and identification of celestial objects using a graphical interface, calculation of rise, set and transit times and a tool for calculating great circle and rhumb line tracks.

6. CONTINUOUS IMPROVEMENT

HMNAO are always looking to improve the various products. The upcoming 2016 edition of *The Nautical Almanac* and its electronic version will include a new section on Polar Phenomena. This will allow the user to approximate the durations of sunlight, moonlight and twilight at very high latitudes throughout the year.

7. USER FEEDBACK

HMNAO welcomes feedback from the varied users of the almanac services, including navies and commercial shipping from around the world. Members of HMNAO have travelled aboard ships and attended celestial navigation training given to navies in order to gain an important insight into how the publications and software are used in practice and to listen to the opinions of mariners who use them. This feedback is helpful in the continuous improvement of the products.