

# Preface

A book on the history of the nautical almanac was proposed by Springer, who realized that while books have been written about the longitude problem and the Harrison clocks that solved the problem in one way, the complete story of the founding of the Royal Observatory, the Nautical Almanac Offices in both the UK and the USA, and the interesting people involved has not been told. An amazing milestone is that *The Nautical Almanac* has now been published for over 250 years. Thus, at the General Assembly of the International Astronomical Union in Vienna in 2018, a meeting was held between Springer's Senior Editor for Astronomy, Astrophysics, Planetary, and Space Science, Neil Scriven; "Historical and Cultural Astronomy" Series Editor, Wayne Orchiston; and long-time member of HM Nautical Almanac Office and the Royal Greenwich Observatory (RGO), Catherine Y. Hohenkerk. This resulted in a plan to approach various authors, who would bring their experience and knowledge to the subject, and importantly to find someone to coedit the book with Catherine Y. Hohenkerk. P. Kenneth Seidelmann was an obvious choice, not only due to his wide experience in astronomy, but also, he had been at one time responsible for almanacs at the US Naval Observatory. It was also known that he was now doing research on the history of the different nautical almanac offices and their equivalent institutions.

The history of the nautical almanacs is largely about the UK and US Nautical Almanac Offices. The founding of the Royal Observatory in 1675 to "... find out the so-much desired longitude of places for the perfecting of the art of navigation ..." and the UK's leadership in astrometric observations for navigation, which was the reason the Greenwich meridian was later selected as the prime meridian for longitude, has to be included. In other countries, initially, the French *Connaissance des temps* was a publication for astronomers. The Berlin Observatory was founded based on a calendar tax to introduce the Catholic Gregorian Calendar in a Protestant country, and the astronomy was not for navigation purposes. Thus, these almanacs and ephemerides are not discussed. Over the years, the UK and US *nautical almanacs* were and are copied by many countries, mostly with permission. Also, the history of celestial navigation through to the present day is largely undocumented, and this was an opportune time to record some of these details.

An outline of the book was prepared by the editors, and the authors were sought to cover the various stages of the history, including international cooperation, the developments in reference systems and astronomical constants, the introduction and application of calculators and computers, and the changes in celestial navigation, including its role with respect to radio and satellite navigation systems.

The authors who agreed to participate come from the fields of history and science, and, therefore, the chapters have different styles. We have made no attempt to unify this; each chapter is their story of what took place. We also have the differences in spellings between UK and US English, this being a traditional difference between the UK and US Almanac Offices (e.g., centre and center). There is a lot of old English and nonstandard spellings, from quotes, in the early chapters. The following highlights the chapters and their authors. Further details about each author, with their picture, are given in their short biographies.

The foreword to the book is written by Owen Gingerich, a renowned Astronomer and Historian who sets the scene with the tale of Columbus' use of almanac data to impress the native Indians. He also comments on the issue of ephemerides accuracies prior to the Royal Observatory.

Chapter 1, by P. Kenneth Seidelmann, is a summary of worldwide astronomical data prior to the Royal Observatory and the development and publication of almanacs due to the availability of the printing press. This chapter is based on a paper just published, "A History of Western Astronomical Almanacs."

Chapters 2 and 3, written by Adam Perkins, who was the Royal Greenwich Observatory Archivist and on the RGO's closure became Curator of Scientific Manuscripts at Cambridge University Library, highlight the financial difficulties in the early years of astronomical observations in England and the disputes that involve some well-known British astronomers, whose relationships are not well known. Chapter 2 deals with King Charles II and the reasons behind his issue of a warrant for the founding of the Royal Observatory. Naturally his Astronomer Royal, John Flamsteed, is discussed, as is the instrumentation of the observatory and his accomplishments. Many observations were made, but publication of the observations was a problem. In Chapter 3, we learn that the Royal Observatory itself did not solve the problems of navigation. Flamsteed and Halley were pursuing their own objectives, and Newton published his magisterial *Principia Mathematica*, but no astronomical data for navigation was forthcoming. Rather, following the 1707 disaster at sea, the British government set up the Board of Longitude to find a method for solving the longitude problem and to adjudicate on a substantial prize for a solution.

Jim Bennett, Keeper Emeritus at the Science Museum, London, an expert in sixteenth- and seventeenth-century astronomy and navigation, agreed to write about the origin and early years of the first British "officially printed" almanac for navigators. Thus, Chapter 4 is about Nevil Maskelyne, who introduced the method of lunar distances and the need for the publication of a nautical almanac. Once appointed Astronomer Royal, he quickly gets approval from the Board of Longitude and starts the first *Nautical Almanac and Astronomical Ephemeris* for 1767.

Chapter 5 focuses on the history during the nineteenth century, both in Britain and in the USA. Thus, this chapter has two authors: Adam Perkins, who authored Chapters 2 and 3, and Steven Dick, who was Astronomer and Historian of Science

at the US Naval Observatory. Problems with the *nautical almanac* result in the appointment of a superintendent, and then a Nautical Almanac Office is set up in Britain. In the USA, in order to be independent, a Nautical Almanac Office is established in 1849 in Cambridge, Massachusetts, and the founding period and the Simon Newcomb era are described.

In the late nineteenth century, international cooperation begins with the establishment of the Greenwich meridian as the prime meridian, and cooperation between the nautical almanac offices in the many different countries commences. Chapter 6, authored by P. Kenneth Seidelmann, describes both the beginning of this international cooperation and how it progresses through the twentieth and into the twenty-first century.

Chapter 7, a collaboration between Catherine Y. Hohenkerk and Bernard Yallop, Superintendent of HM Nautical Almanac Office (1991–1998), covers the era of the twentieth century. It highlights the influences, and the development of the collaboration, between the UK and US Nautical Almanac Offices and the almanacs they jointly produce, particularly those for navigation, both at sea and in the air. The chapter includes the introduction of calculators and electronic computers in the generation of almanac data and the typesetting processes that produce the printed pages.

In Chapter 8 the international development of celestial and terrestrial reference systems during the twentieth and twenty-first centuries are described by Dennis McCarthy, who was Director of Time at the US Naval Observatory. Reference systems are the fundamental bases for the data in the almanacs.

Chapter 9, the last chapter, is a collaboration by three people, John Bangert and George Kaplan, both retired from US Naval Observatory, and Steve Bell, currently at HM Nautical Almanac Office. Their careers have had much to do (and still do) with ensuring the continued management, the science, and the quality and actually producing the data in the almanacs in fast-changing turbulent times. This chapter describes the current status of the almanacs and the current role of celestial navigation in the days of radio and satellite navigation systems.

Hence, this book presents the history of the founding of the Royal Observatory for the purpose of providing a means of navigation in the seventeenth century and the start of printing a *nautical almanac* for disseminating astronomical data for celestial navigation in the eighteenth century. Then, in the nineteenth century the development of the UK Nautical Almanac Office with a superintendent and the founding of the US Nautical Almanac Office are described. International cooperation in astronomical standards for reference systems and constants becomes important in the late nineteenth and twentieth centuries. In the twentieth century international cooperation in the preparation of the almanacs and the impacts of calculators, computers, and typesetting systems are documented. The current role and status of celestial navigation is described. In summary, the history of celestial navigation over five centuries with the changes in technology and development of competing navigation systems is given.

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# Biographies of Authors



**John A. Bangert** retired in 2013 from the US federal civil service, where he served for 34 years, 29 of which were spent at the US Naval Observatory. He started there as a Staff Astronomer in the Nautical Almanac Office and in 1990 was named Chief of the Product Development Division in the new Astronomical Applications (AA) Department. In 1997, he was selected to head the AA Department where he was responsible for a broad range of printed, software, and Web-based astronomical data products for use in military and civilian applications. He received his BS and MS degrees in Astronomy from Villanova University and the University of Pennsylvania, respectively.



**Steven A. Bell** graduated from the University of St. Andrews in Fife with a BSc (Hons.) in Astronomy and Astrophysics in 1983. After being awarded a Doctor of Philosophy in 1987 for his thesis “A Study of Early-Type Close Binaries” from St. Andrews, he held three postdoctoral positions working on close binary systems. He joined HM Nautical Almanac Office in 1993 as a Scientific Editor working on *The Astronomical Almanac* and wrote *The RGO Guide to the 1999 Total Eclipse of the Sun* in 1998. After the closure of the Royal Greenwich Observatory and HMNAO’s relocation to the Space Science and Technology Department of the Rutherford Appleton Laboratory in Oxfordshire, he became HMNAO Project Responsible Officer in 1998. Following HMNAO’s latest relocation to the UK Hydrographic Office in 2006, he became Head/Team Leader of the HMNAO team.



**Jim Bennett** began his museum career in 1977 as Curator of Astronomy at the Old Royal Observatory, Greenwich, in the Department of Navigation and Astronomy headed by Derek Howse, Historian of Greenwich Time and Biographer of Nevil Maskelyne. These interests remained through subsequent museum positions in Cambridge, Oxford, and the Science Museum, London, and research and publication in the history of astronomy and practical mathematics. He has served as President of the British Society for the History of Science and of the Scientific Instrument Commission of the International Union of History and Philosophy of Science. He is currently President of the Hakluyt Society. In his Greenwich period, Derek Howse liked to introduce him as “Keeper of the Meridian.”



**Steven J. Dick** served as the NASA Chief Historian and Director of the NASA History Office from 2003 to 2009 and prior to that as an Astronomer and Historian of Science at the US Naval Observatory for more than two decades. He has held the Baruch S. Blumberg NASA/Library of Congress Chair in Astrobiology at the Library of Congress and has testified before the United States Congress on the subject of astrobiology. He has also held the Charles A. Lindbergh Chair in Aerospace History at the National Air and Space Museum. He is the Author or Editor of 25 books, including most recently *Astrobiology, Discovery, and Societal Impact* (Cambridge, 2018) and *Classifying the Cosmos: How We Can Make Sense of the Celestial Landscape* (Springer, 2019). He received the LeRoy E. Doggett Prize from the American Astronomical Society for a career that has significantly influenced the field of the history of astronomy. Minor planet 6544 Stevendick is named in his honor.



**Owen Gingerich** is Professor Emeritus of Astronomy and History of Science at the Harvard-Smithsonian Center for Astrophysics. He pioneered the use of modern high-speed computers to explore the physical structures of stellar atmospheres. By and by, he learned from historians of science of the desirability of calculating an extensive grid of planetary positions in antiquity, which he published in 1963 as *Solar and Planetary Longitudes for Years -2500 to +2000 by 10-Day Intervals*. Gradually, he developed a deep

interest in the work of Nicolaus Copernicus, traveling thousands of miles to personally inspect nearly 600 sixteenth-century copies searching for scarce but highly informative annotations. The results of this three-decade investigation appear in his *An Annotated Census of Copernicus' De Revolutionibus* (Nuremberg, 1543 and Basel, 1566). Likewise, the technical work of Johannes Kepler provides excellent targets with splendid availability.



**Catherine Y. Hohenkerk** started working at Royal Greenwich Observatory straight from school in 1971. Obtaining an HNC in Mathematics, Statistics and Computing, followed by a BSc (Hons.) in Mathematics, both by day release. She worked in the Solar and Computer Departments before being transferred to HM Nautical Almanac Office in 1978, where she remained, despite the closure of the Observatory and the relocation to Rutherford Appleton Laboratory in 1998, and then to the UK Hydrographic Office in 2006, until retirement at the end of January 2017. During her career she has been involved with the content, programming and production of all the almanacs. In 2005 she was awarded the USNO Superintendents award. She was elected a fellow of the Royal Institute of Navigation and the Royal Astronomical Society. She is a member of the International Astronomical Union, its Division A, Fundamental Astronomy, and has been President of Commissions 4, Ephemerides (2012–2015), and A3 Fundamental Standards (2015–2018); and is Chair of the standing Working Group Standards of Fundamental Astronomy (SOFA), which provides software that support IAU Resolutions.



**George H. Kaplan** was a Staff Astronomer at the US Naval Observatory in Washington from 1971 to 2007, serving in both research and management positions. Currently, he is a part-time independent consultant to USNO. He earned his PhD in Astronomy from the University of Maryland in 1985. His work has involved a wide variety of projects related to positional astronomy, and his publications encompass observation, theory, and practical applications, including navigation. He is a past officer of the International Astronomical Union and a Member of the American Astronomical Society and the Institute of Navigation. Minor planet 16074, Georgekaplan, is named in his honor.



**Dennis D. McCarthy** although officially retired from the US Naval Observatory where he was Science Advisor, Director of the Directorate of Time, and Head of the Earth Orientation Department, is now a Contractor with the Observatory and a Member of US Working Party 7A of the International Telecommunication Union – Radiocommunications Section. Internationally, he is the Representative of the International Astronomical Union (IAU) to the Bureau International des Poids et Mesures and Consultative Committee on Time and Frequency. He has served as President of the Commission on Time, Commission on Earth Orientation, and Division 1 (Fundamental Astronomy) of the IAU. He was also Secretary of Commission 5 of the International Association of Geodesy. He has been a Chair and Member of various working groups within the IAU and the Author and Editor of publications dealing with fundamental astronomy, time, and Earth orientation.



**Adam J. Perkins** after graduating in Physics with Astrophysics in 1973, spent a decade in the energy conservation industry before in 1983 joining the Royal Greenwich Observatory, Herstmonceux Castle, to supervise new cataloguing of the Observatory's Archives. Work first methodically tackled in the 1950s–1960s, this had then lain skeletal and incomplete. Appointed RGO Archivist in 1987, in 1990, he oversaw the transfer of the Archives to a new home in Cambridge University Library when the RGO moved to Cambridge, thus securing the future of the collection. Shortly after joining the staff, he became responsible for all the Library's scientific manuscript collections and was subsequently appointed the University's Curator of Scientific Manuscripts, retiring from the Library in 2016.

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**P. Kenneth Seidelmann** received his PhD degree in Dynamical Astronomy from the University of Cincinnati. He was Director of the Nautical Almanac Office and of the Directorate of Astrometry of the US Naval Observatory. He is a Research Professor in the Astronomy Department of the University of Virginia.

He is coauthor of *Fundamentals of Astrometry* and both editions of *Time: From Earth Rotation to Atomic Physics* and *Celestial Mechanics and Astrodynamics: Theory and Practice* and Coeditor of the *Explanatory Supplement to the Astronomical Almanac*. He has authored, or coauthored, over 200 scientific papers and edited, or coedited, over 25 scientific books.

He is a Member of the International Astronomical Union, American Astronomical Society, American Institute of Aeronautics and Astronautics, and Sigma Xi and a Fellow of the American Association for the Advancement of Science, the Institute of Navigation, and the Royal Astronomical Society.



**Bernard D. Yallop** following a mathematics degree at Imperial College, London, went on to obtain a PhD on the *Background Radiation of the Universe from Galaxies* in 1962. He joined the Royal Greenwich Observatory in 1960, having attended one of its popular summer schools to take a position in the Meridian Department. This resulted in taking charge of the transit circle at the Cape Observatory in South Africa for 3 years. On return, and after working in astrophysics with Bernard Pagel and later Donald Lynden-Bell, he transferred in 1973 to HM Nautical Almanac Office to take charge of the publications. With the advancements in computing, his mission was to improve and automate the production process. The availability of personal computers led to the development of easy-to-use algorithms and provision of almanac data for determining position at sea. For 8 years before retirement, he was Superintendent, with the pivotal role of ensuring to continue its mission and its historic name, despite the closure of the Observatory. He is a Member of the International Astronomical Union and was President of Commission 4 (Ephemerides) and served on Resolutions Committee at the 1996 General Assembly.