Preface – 1st Edition

Theodor von Oppolzer's 1887 *Canon der Finsternisse (Canon of Eclipses)* stands as one of the greatest accomplishments in computational astronomy of the 19th century. It contains the elements of all 8,000 solar eclipses (and 5,200 lunar eclipses) occurring between the years –1207 and +2161 (1208 BCE and 2161 CE, respectively), together with maps showing the approximate positions of the central lines. To make this remarkable achievement possible, a number of approximations were used in the calculations and maps. For instance, the central line path of each solar eclipse was computed for only three positions: sunrise, mid-point, and sunset. A circular arc was fit through the points to depict the eclipse path. Consequently, the central lines often differ by hundreds of miles compared to rigorous predictions generated with modern ephemerides. Furthermore, the 1887 Canon took no account of the shifts imparted to ancient eclipse paths as a consequence of Earth's variable rotation rate and the secular acceleration of the Moon.

Subsequently, special eclipse canons were published for shorter time intervals or for limited geographic regions. Ginzel's *Spezieller Kanon* (1899) dealt with eclipses in the period –900 to +600 (901 BCE to 600 CE), while Schroeter (1923) produced charts and data for solar eclipses visible in Europe from +600 to +1800 (600–1800 CE).

With the arrival of the electronic computer, the time was ripe to produce an updated eclipse canon. In 1966, Meeus, Grosjean, and Vanderleen published *Canon of Solar Eclipses* containing the Besselian elements of all solar eclipses from +1898 to +2510 (1898–2510 CE), together with central line tables and maps. The aim of this work was principally to provide data on future eclipses.

The next canon (Mucke and Meeus, 1983) was intended mainly for historical research and covered the period –2003 to +2526 (2004 BCE to 2526 CE). Thus, it was effectively the modern day successor of Oppolzer's great canon. The Mucke-Meeus publication included Besselian elements and maps of all 10,774 solar eclipses during this time interval. Each orthographic map was oriented to show the day-side hemisphere of Earth. In this projection, the path of the Moon's penumbra and the central axis of the shadow cone could be approximated by straight lines.

Several other special canons have been produced. Stephenson and Houlden (1986) published an atlas of annular and total eclipses visible in East Asia from –1499 to +1900 (1500 BCE to 1900 CE). Espenak's *Fifty Year Canon of Solar Eclipses* (1987) included individual detailed maps and central path data for all solar eclipses from +1986 to +2035 (1986–2035 CE).

Without exception, all solar eclipse canons produced during the latter half of the 20th century were based on Newcomb's tables of the Sun (1895) and Brown's lunar theory (1905), subject to later modifications in the *Improved Lunar Ephemeris* (1954). These were the best ephemerides of their day but they have now been superseded.

The present book contains detailed, accurate maps (found in the Appendix at the back of the book) for 5,000 years of solar eclipses, from –1999 to +3000 (2000 BCE to 3000 CE). The following points highlight the features and characteristics of this work.

- Based on modern theories of the Sun and the Moon constructed at the *Bureau des Longitudes* of Paris rather than the older Newcomb and Brown ephemerides.
- Ephemerides and eclipse predictions performed in Terrestrial Dynamical Time.
- Covers historical period of eclipses, as well as one millennium into the future.
- Global maps for each eclipse depict the actual northern and southern limits of the Moon's penumbral and umbral or antumbral shadows, as well as the sunrise and sunset curves.
- Maps include curve of eclipse magnitude 0.5.
- Maps include continental outlines with contemporary political boundaries and are large enough to identify geographic regions of eclipse visibility.
- Maps are based of the most current determination of the historical values of ΔT.
- Estimates of eclipse path accuracy based on the uncertainty in value of ΔT (i.e., standard error in ΔT)

A primary goal of this work is to assist historians and archeologists in the identification and dating of eclipses found in references and records from antiquity. This is no easy task because there are usually several possible candidates. Accurate maps using the best available values of ΔT coupled with estimates in the standard error of ΔT, are critical in discriminating among potential eclipse candidates. Ultimately, historical eclipse identification can lead to improved chronologies in the timeline of a particular culture.

A certain synergism exists here because new eclipse identifications in the historic record can lead to new data in the determination and refinement of the historical value and behavior of ΔT. Improved values of ΔT can then lead to the positive identification of more eclipses in the historical record.

The maps can also be used to quickly estimate the approximate circumstances for any geographic location during each eclipse without any calculations. Because the northern and southern limits of total and annular eclipses are plotted, it is readily apparent by inspection whether a location is within the umbral or antumbral path. The northern and southern limits of the penumbral shadow and the curve of eclipse magnitude 0.5 can be used to estimate the magnitude of a partial eclipse. The position of the sub-solar point at greatest eclipse shows the apparent noon meridian, while the penumbra's rising and setting curves depict the regions where the eclipse is in progress during sunrise and sunset, respectively. All this can be accomplished simply by inspecting the maps.

The Canon will also be of value to educators, planetariums, and anyone interested in knowing when and where past and future eclipses occur. The general public is fascinated by eclipses. With each major eclipse, the question always arises as to when a particular location experienced its last and next eclipses. The maps presented here are ideally suited to addressing such queries.

Finally, if this work inspires any student to pursue a career path leading to the sciences, then we have achieved the greatest success we could possibly hope for.

— Fred Espenak and Jean Meeus, 2006 June

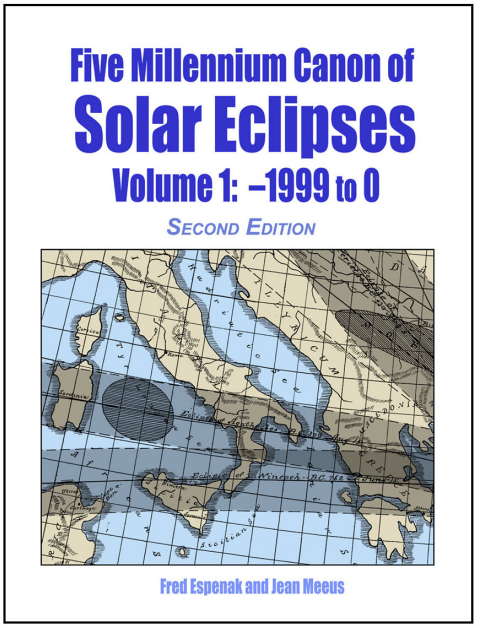
Preface – 2nd Edition

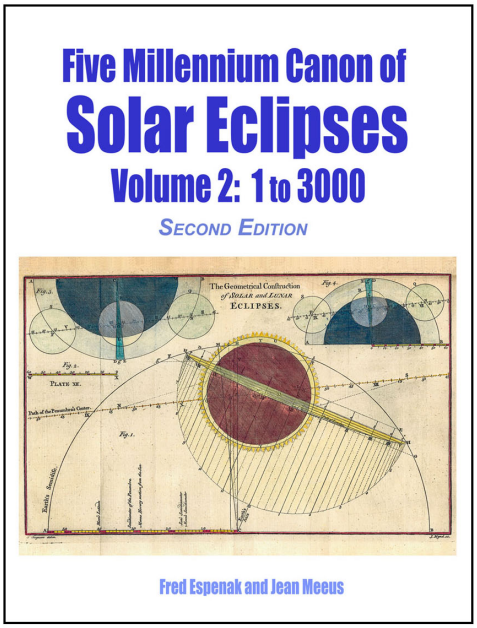
The *Five Millennium Canon of Solar Eclipses: –1999 to +3000* was first published in October 2006 (NASA TP-2006-214141). As a NASA Technical Publication it had a limited publication run and distribution. The available supply of hard copies was depleted within 12 months of publication although the PDF version continues to be available).

Fifteen years later, the *Five Millennium Canon of Solar Eclipses* is available again in hard copy in this Second Edition through Astropixels Publishing. Because of the large number of pages in the publication it has been necessary to create a completely new layout for the book, and to divide it into two parts.

Volume 1 covers eclipses for the years -1999 to 0, while volume 2 covers eclipses for the years 1 to 3000. A new section (Section 4: Eclipses and the Moon's Orbit) has also been added to this second edition.

— Fred Espenak and Jean Meeus, 2021 July





See: *http://astropixels.com/pubs/5MCSE2.html*