Exploring the 584286 Correlation between the Maya and European Calendars

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> As a matter of fact, the whole problem of the proper correlation of Maya and Christian chronology may be reduced to precisely this: the correct engagement of the Mayan and Julian Periods at any single point; for if it were possible to establish a single point of contact between the two, every date in Maya chronology could be transcribed into its corresponding Julian or Gregorian equivalent, and the dates on the Maya monuments would suddenly become more accurately fixed in our own chronology than any event of Old World history prior to the birth of Christ... (Morley 1920:465)

In this paper we return to a topic that has vexed and intrigued Mayanists for well over a century—a precise correlation between the chronology described in Classic Maya inscriptions and the modern European calendar. A great many solutions to the problem have been proposed in this time, although none has succeeded in resolving all the inconsistencies in the data and thereby gained universal support. In this further exploration of the problem, we have been inspired by the only single-day astronomical event in the ancient texts to have gained any wide currency among epigraphers. This event was recorded in both the Maya and European calendars and therefore provides a direct correlation between the two. We have sought to explain how this can be reconciled with the evidence left to us by Diego de Landa and the Maya chroniclers of the early Colonial Period. At the heart of this analysis lie certain idiosyncrasies of the Maya calendar revealed by previous researchers that we believe to have more telling implications than hitherto realized.

When we speak of correlating the calendars, it is important to bear in mind that there are actually two different scales of magnitude at issue—the distinction between a precise correlation and what might be termed a general one that dates the events of Maya recorded history to within a decade or even a century. How do we know that a great Maya king like K'inich Janaab Pakal was born around AD 600 (according to the Goodman-Martínez-Thompson correlation) rather than AD 1100 (per the Vaillant) or AD 100 (per the Bowditch)?[1] Roughly aligning the two calendars to within a matter of months makes it possible to say, and such a correlation had been achieved by the middle of the last century with the result that the Goodman-Martínez-Thompson correlation has been almost universally accepted and corroborated to a significant extent by radiocarbon dating.[2] But such acceptance must still remain somewhat provisional until such time as a "single point of contact" (Morley 1920:465) links the two calendars with absolute precision. This correlation-to-the-day is what it will take to prove the broader correspondence once and for all. Therefore debate has been ongoing over correlations expressed as numbers that differ by at most a few digits, these digits representing days in one direction or another.

The two most widely accepted correlations are 584285 and 584283. These numbers are "correlation constants" that express the base date of the Maya calendar as its Julian Day Number. The system of assigning a Julian Day Number to every day that has elapsed since January 1, 4713 BCE, is used by astronomers to record celestial events.[3] Thus the Maya base date of 13.0.0.0.0 4 Ajaw 8 Kumk'u is Julian Day Number 584285 in one of the popular correlations—that is, it fell 584,285 days after January 1, 4713. As we shall see, it is not necessary to understand or even use Julian Day Numbers in the correlation, but it is customary.

Thompson (1927, 1935, 1950) arrived at 584285 by means of a line of reasoning initiated by Goodman (1905) and revived by Martínez Hernández (1926). This begins with a proposition derived from Colonial-era

[1] The Goodman-Martínez-Thompson ("GMT") correlation is actually a "family" of correlations ranging from 584280 to 584285 (Lounsbury 1978:808), while the 394483 correlation is "modified Bowditch" and 774083 is "Vaillant, second preference" (Kelley 1976:31). See Kelley (1976:31) for a compendium of some three dozen correlations that have been proposed. For a comprehensive treatment of the correlation topic, see Bricker and Bricker (2011:77-99); also see Aveni (1980:204-210).

[2] On the basis of Colonial-era ethnohistorical documents, Bricker and Bricker (2011:79-87) make a compelling case for its correctness.

[3] Because astronomers employ a year "zero," the base date is also written as January 1, -4712. Note that the Julian Day Number system of astronomical reckoning is not to be confused with the Julian calendar, which preceded the Gregorian calendar that we currently use.

Maya chronicles and Diego de Landa's *Relación de las cosas de Yucatán*, that the Maya date 11.16.0.0.0 13 Ajaw 7 Xul fell in the year 1539 CE. Added to this was the fact that Landa had recorded that 12 K'an 1 Pop (New Year's Day in the Colonial Maya calendar) coincided with July 16 in his own, with that date apparently falling in 1553.

Since 13 Ajaw 7 Xul and 12 K'an 1 Pop were deemed "impossible" dates in the Classic-period Maya calendar, Thompson (1935) began by assuming that at some point after the Classic there had been a "break of a day" and that the Landa date expressed in the Classic system would be 12 K'an 2 Pop. We will return to this point later. By following the regular pattern of the Maya Calendar Round and counting the days between the "corrected" 11.16.0.0.0 13 Ajaw 8 Xul and the subsequent 12 K'an 2 Pop, one arrives at a Long Count date of 11.16.13.16.4 (the Long Count had fallen out of use, but like Thompson we retain it for calculation purposes).

A Long Count date is similar to a Julian Day Number in that both record the number of days elapsed from a base date. The Long Count 11.16.13.16.4 records what has been termed a "Maya Day Number" of 1,704,204 days since 13.0.0.0.0 4 Ajaw 8 Kumk'u, as follows:

11 Bak'tuns	=	1,584,000 days
16 K'atuns	=	115,000 days
13 Tuns	=	4,680 days
16 Winals	=	320 days
4 K'ins	=	4 days
		1,704,204 days

Given that the Julian Day Number for July 16, 1553, is 2288488, Thompson's initial calculation arrived at the following result:

2288488	Julian Day Number
- 1704204	Maya Day Number
584284	

Accounting for the "break of a day" brought Thompson to 584285. Subsequently (see Proskouriakoff and Thompson 1947), Thompson found dates like Landa's in the Classic-period inscriptions, where the numerical coefficient of the month position was one less than expected. Due to their concentration in the Puuc sites of the northern lowlands, this system was eventually dubbed "Puuc-style dating." Accordingly, Thompson decided that there had been no "break of a day" after all between the Classic and Landa's time, which brought him back to 584284. By that time surviving 260-day calendars had been identified in some parts of the Maya highlands and shown to be in close accord with the system recorded for Central Mexico. Since this was a further day removed, Thompson (1950:304) took up an argument first put forward by Martínez Hernández (1926) that it was some years earlier than 1553 when Landa had collected the information that the Maya New Year fell on July 16 and that Landa had failed to account for an intervening leap year. This led Thompson to 584283, a correlation constant popular with many scholars today, particularly those who hold that the count kept by "day keepers" in the Guatemalan highlands is part of an unbroken tradition (see Bricker and Bricker 2011:90-93; Prager and Sachse 2009).

What Thompson did not have the benefit of understanding came in a breakthrough by Peter Mathews. Discussing the inscription on the back of Dos Pilas Stela 8, Mathews (2001[1979]:404-406) suggested that the inscribed date 3 K'an 1 K'ank'in—a date like Landa's, where the coefficient of the month position was one less than expected—was neither a scribal error nor an early example of a system that had become the norm by Landa's time. Instead it recorded a nighttime event.

In order to illustrate his point, Figure 1 gives a graphic representation of the Long Count, *tzolk'in*, and *haab* aligned in the manner assumed by previous researchers, each in lockstep with the other. At whatever point the transition took place—and here we have set it at sunrise—a date such as 9.14.15.2.3 2 Ak'bal 1 K'ank'in would be followed by 9.14.15.2.4 with a *tzolk'in* of 3 K'an and a *haab* of 2 K'ank'in.

While the appearance of 3 K'an 1 K'ank'in in the midst of conventional combinations on Stela 8 could have been attributed to a scribe's mistake, Mathews focused attention on the preceding glyph. This was a head with an infixed sun sign and cross-hatching prefixed by a preposition, a form that also introduces a "misaligned" date at Yaxchilan, and he conjectured that it meant "in the night" or "at night." The unusual alignment of the *tzolk'in* and *haab* implied that the former changed at a different time of day than the latter, for example at 6 PM, and that if an event took place in

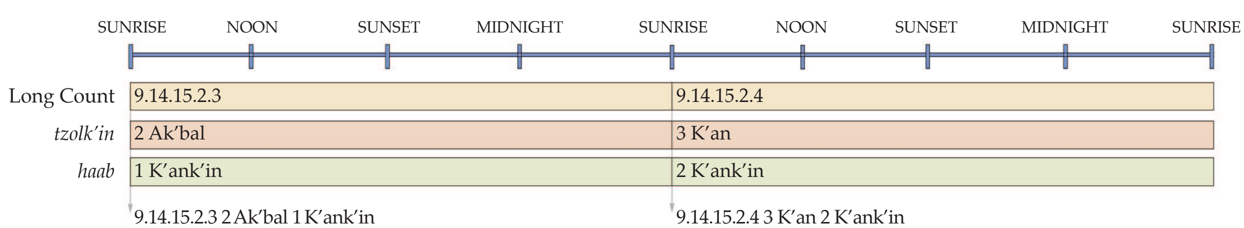


Figure 1. 9.14.15.2.3 2 Ak'bal 1 K'ank'in and the following day.

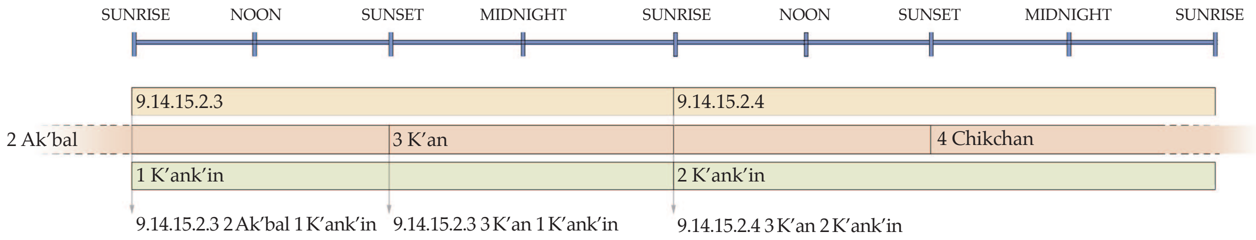


Figure 2. The *tzolk'in* changing at a different time than the *haab*.

the middle of the night, "then the *tzolk'in* date would be one position advanced with respect to the *haab* date" (Mathews (2001[1979]:406). Figure 2 shows the effect of the *tzolk'in* changing at a different time of day than the *haab*.

Since most events happen in the daytime, the calendrics of most inscriptions are of the expected form. But since some events would have happened at night, a minority of inscriptions display a date like Landa's, thereby revealing the otherwise hidden workings of the Maya calendar.

It should be noted that a date of this type would have resulted if the *tzolk'in* customarily changed at midnight rather than the 6 PM of the example, as long as the recorded event happened between midnight and dawn. But it seems more likely that the change in the *tzolk'in* would have been tied to an observable event such as sunset. In fact there are good ethnographic parallels from the Guatemalan highlands for the *tzolk'in* day being construed to begin with the setting of the sun (La Farge 1947; Lincoln 1942). In like manner, the most probable point of transition for the *haab* would be at sunrise.

The offset of *tzolk'in* and *haab* raises a further question: at which of the two transition points did the Long Count change? While this question cannot be answered with certainty based on the Dos Pilas inscription,[4] strong support for a *haab* transition—and the nighttime system as a whole—comes from Copan Altar H'. Here the opening date is a distinctly unusual 9.12.8.3.9 *8 Muluk 9 Ok 17 Mol (Morley 1920:186-189).[5] The provision of two *tzolk'in* positions evidently describes an event that spanned both; that is, one that took place not only during the day but into the evening or night as well. With both positions covered by a single Long Count it is clear that the latter cannot be shifting at the *tzolk'in*. Supporting evidence for the Long Count changing with the *haab* also comes from the inscription of the recently discovered hieroglyphic stairway of El Palmar, Quintana Roo.[6]

David Stuart (2004a) has confirmed the finding by Mathews and contributed to our understanding of the nighttime system with his analysis of an unprovenanced inscription now in the Hecelchakan regional museum. This describes the *tzolk'in* 4 Muluk as "entering" the *haab* 16 Mak, one day in advance of its conventional partner 17 Mak. Hecelchakan is adjacent to the Puuc region, and Stuart drew the inference from this that Puuc-style dates are not a distinct system, but simply accounts of nighttime events, which may have been of special interest to the cities of this area. Stuart suggested that this practice was later "fossilized" to become the new norm, producing Calendar Rounds of the kind seen in Landa's time lasting for a full 24-hour period.[7]

To return to Thompson's study of the correlation—together with that of a great many other experts—arguments from historical documents had gone as far as they could without achieving an incontrovertible result (which remains the case to this day). Therefore

[4] On Stela 8 a Distance Number connects a daytime event on 9.14.15.1.19 11 Kawak 17 Mak to our nighttime event on 3 K'an 1 K'ank'in, a figure that should be five days if Kawak is counted to K'an, but only four days if 17 Mak is counted to 1 K'ank'in. In fact, it gives three days, which must be a mistake. Nevertheless, for Mathews (2001[1979]:402-403, 406) this implied that the Long Count advances in step with the *haab*, since this requires only a one-day error whereas a setting to the *tzolk'in* would require an error of two.

[5] The date is securely placed by a Distance Number of 1.14.11 that connects to the Period Ending 9.12.10.0.0. Although today the *haab* more resembles 18 Mol, Morley expressed no reservations that 17 Mol was written—presumably because the central "dot" was visibly a space-filler in his day. We thank David Stuart (personal communication 2011) for drawing this passage to our attention.

[6] We are grateful to Kenichiro Tsukamoto and Octavio Esparza Olguín (personal communications 2012) for sharing this inscription.

[7] That such a "fossilization" took place is the best explanation of the change in year bearers that occurred between the Classic and Landa's time. Though the point is tangential to our purposes here, it might be mentioned in passing that a K'atun-ending like that of 9.12.0.0.0—recorded in full on Edzna Stela 18—being set at 10 Ajaw 7 Yaxk'in (with 8 Yaxk'in expected) implies that the Long Count has lost its tether to the *haab* and is instead locked to the *tzolk'in*. Period Endings may be the key to this development. The perpetual arrival of the *tzolk'in* ahead of the *haab* means that the required day of all Period Endings, Ajaw, must begin the evening before its conventional month partner. Outside the Puuc area the K'atun-ending was celebrated the next day when the *haab* had advanced to 8 Yaxk'in and the Long Count turned to 9.12.0.0.0. However, in the Puuc region they seem to have preferred to mark this event the evening before, linking the K'atun-ending directly to the arrival of Ajaw and in the process moving the transition point of the Long Count. A further shift permanently aligning all three components of Long Count, *haab*, and *tzolk'in* would have entailed a one-day displacement of the Classic-period year bearers—Ik', Manik', Eb, and Kaban (D. Stuart 2004b)—to Ak'bal, Lamat, Ben, and Etz'nab. And when New Year's Day came to be celebrated on 1 Pop rather than 0 Pop this would have caused a further shift to K'an, Muluk, Ix, and Kawak, the year bearers of Landa's time.

Figure 3. (a) Teeple's drawing of a "possible eclipse glyph" (Teeple 1931:Fig. 19); (b) Postclassic eclipse glyph (drawing by Simon Martin); (c) Copan block (photograph by Linda Schele, courtesy of David Schele); eclipse glyph from K5359 (detail of drawing by Simon Martin from Miller and Martin 2004:Fig. 21, based on photograph K5359 by Justin Kerr).

arguments from astronomy were mustered in an attempt to settle the issue. But the problems facing this approach proved to be daunting, given the lack of clarity about precisely what celestial events the Maya were recording in their inscriptions and whether observation or calculation was the presiding principle. The Julian Day Numbers of any number of solstices, risings of Venus, or phases of the moon were available from astronomy. Where such events were thought to be recorded in the inscriptions, their Maya Day Numbers yielded correlation constants that were only off by a matter of digits from 584285 or some competing correlation. But near misses were hardly sufficient to prove a point.

There was one inscription, however, that might have made a tremendous difference, and Thompson was even aware of it; he wrote: "It has been claimed that Stela 1 at Poco Uinic records an eclipse[...] According to the Oppolzer tables the eclipse, which was total in Central America, occurred on [Julian Day Number] 2009802" (Thompson 1935:74).

Since the subtraction of the relevant Long Count from this number results in a correlation constant of 584286—one more than Thompson's then-preferred 584285—he did not find the Poco Uinic stela at all useful for his purposes, except in using it to dismiss the 584281 correlation advocated by Martínez Hernández. But let's look at this inscription for ourselves with fresh eyes.

The hieroglyph at issue was first noted on Poco Uinic Stela 3 (Thompson's "Stela 1") by John Teeple (1931:115), where it follows a Calendar Round of 5 Kib 14 Ch'en that is unambiguously fixed to the Long Count at 9.17.19.13.16 (Figure 3a).[8] It shows a central sun sign with two flanking motifs, a reasonable match to the eclipse signs that appear in the Postclassic codices (Figure 3b). There, signs for the sun and moon are flanked by lobes painted black and white, representing solar and lunar eclipses respectively. The closest Classic-period analogues for these appear on a loose block at Copan (Figure 3c), probably from an iconographic scene rather than a text, and on a polychrome vessel K5359 (Figure 3d), which by comparison with Madrid Codex page 67b, shows a clear lunar eclipse (Hull 2000:6; Martin 2005).

The flanking lobes on the Poco Uinic version differ in having crossed bands within them. Teeple compared them to a similar-looking sign in Glyph B of the Lunar Series, which he thought could represent a house but which we now read as part of the logogram **K'ABA'** "name." The Corpus of Maya Hieroglyphic Inscriptions at the Peabody Museum of Harvard University holds photographs of Stela 3, but the relevant glyph is now considerably more eroded than it was Teeple's time. As it stands, his sketch could suggest that we are actually looking at the crossed bands of twin sky signs. Moreover, there is an item of iconography that lends strong weight to the eclipse interpretation for this device. The Kerr database includes a carved vessel, K5197, which shows a clawed beast together with sun and moon signs surrounded by very similar lobes—with what could be the crossed bands of a single, tilted sky sign within and the same fringed base seen at Poco Uinic (Figure 4).

[8] The context is the *tzolk'in* anniversary of a royal accession some eight years earlier on 9.17.11.14.16 5 Kib 14 Keh. To place the eclipse on any other day—as would be demanded by the 584285 or 584283 correlations—is to ignore that it was only recorded at all due to the coincidence of it also falling on 5 Kib.

Figure 4. Vessel K5197 in Justin Kerr's MayaVase database at www.mayavase.com (photograph K5197 © Justin Kerr).

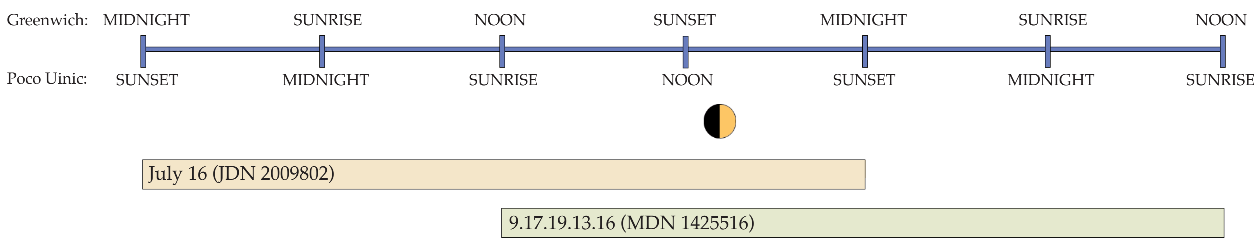


Figure 5. The Poco Uinic eclipse, which occurred on European calendar day July 16, 790 CE and Maya Day 9.17.19.13.16.

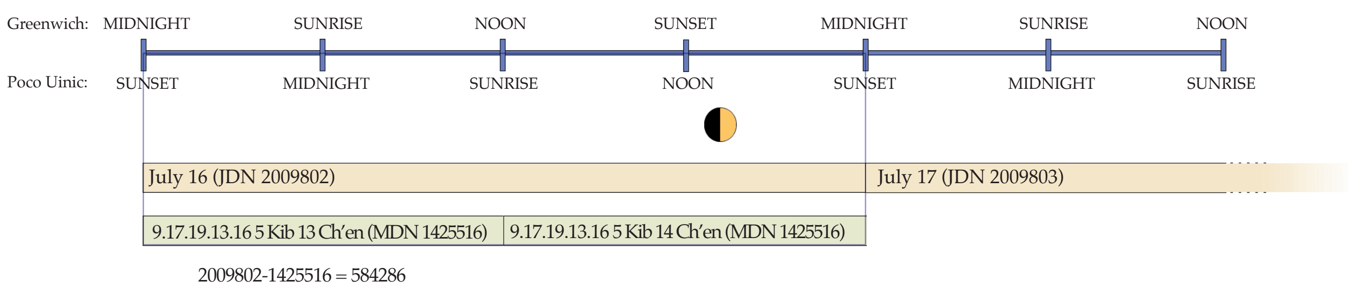


Figure 6. The situation at Poco Uinic showing the Long Count changing at sunset with the *tzolk'in*, such that the entire Maya day 9.17.19.13.16 overlaps with the European calendar day July 16.

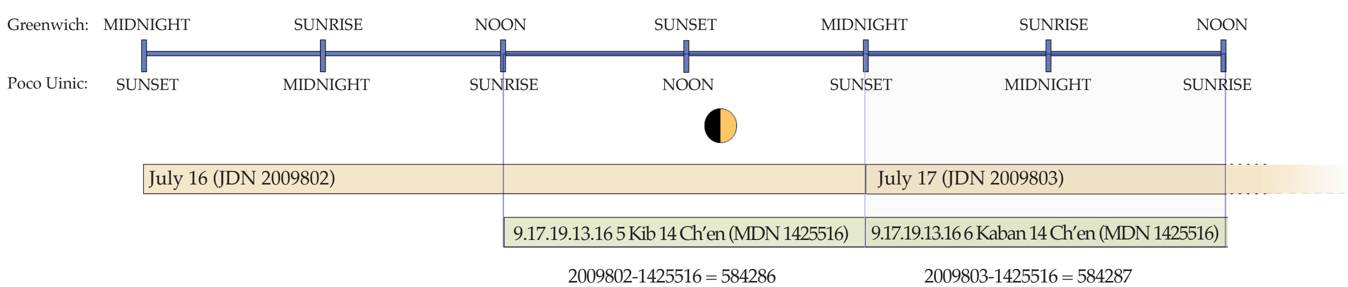


Figure 7. The situation at Poco Uinic showing the first half of the Maya day correlating with the European calendar day between noon and midnight GMT while the second half correlates with a new European calendar day.

According to the astronomer Oppolzer, the eclipse began shortly after sunset Greenwich Mean Time (GMT) on July 16, 790 CE.[9] This was shortly after noon at the longitude of Poco Uinic. The Julian Day Number (JDN) assigned to July 16, 790, is 2009802. The Maya Day Number (MDN) of the Long Count 9.17.19.13.16 is 1425516. Figure 5 shows the situation in graphical form.

Subtracting the Maya Day Number from the Julian Day Number in effect at the time of the eclipse yields a correlation constant of 584286:

2009802 Julian Day Number
\- 1425516 Maya Day Number

584286

Now let's look at the situation in more detail armed with our current understanding of the Classic calendar. The Long Count changes either with the *tzolk'in* at sunset or (as we consider more likely) with the *haab* at sunrise. Figure 6 illustrates the first of these possibilities. Here the entirety of the Maya day 9.17.19.13.16 overlaps with July 16 such that the two calendars correlate unambiguously day-for-day. Expressing this in Julian Day Numbers, the correlation is 584286.

Figure 7 shows the scenario where the Long Count changes with the *haab* at sunrise. In this case, the Maya day 9.17.19.13.16 correlates to two different European calendar days, July 16, 790 and July 17, 790. Expressing this with Julian Day Numbers yields two different correlation constants: 584286 and 584287.

[9] Although Oppolzer's nineteenth-century eclipse tables are cited in the correlation literature (e.g., Thompson 1935:74), greater accuracy in eclipse modeling has been achieved in the computer era (see for example NASA 2012).

At first it might seem strange that there are two different correlations possible for a single Maya day, but the strangeness is largely owing to the fact that Thompson and his fellow scholars never talked about the possibility.[10] Those of us who use a calendar calculator might also be taken aback because we are used to setting it to one correlation or another and there is no way to set it to two at the same time. But that technical limitation can be coped with in the following manner.

If a Maya inscription records an event that happened in the daytime, then a calculator set to the 584286 correlation will return the appropriate date in the Julian or Gregorian calendar. If the inscription records one of the rare events that happened after dark, then we must add one European calendar day. We must keep in mind that all of the unambiguous celestial events recorded in the inscriptions—and here one thinks specifically of lunar data included in the Initial Series—are there only in reference to daytime events for which they are deemed to have some relevance. It follows that there are no currently-known astronomical events described with a nighttime Calendar Round notation. Though it has long been held that celestial events were a special concern of the ancient Maya, monumental inscriptions focus on the ritual and political affairs of the elite, with astronomical information playing only an incidental role. Of course, this emphasis may well have been reversed in many of the once-legion screenfold books, which were doubtless used to keep celestial records.

The idea of deriving two different correlations from a single Maya day was previously proposed by Vincent Malmström (1999), who used the Poco Uinic inscription to illustrate his point. Malmström's analysis is based on a number of cogent insights, among them the postulate that the Maya day was considered to begin and end at sunset. As we have seen, this is almost certainly true as regards the changing of the *tzolk'in*, and although the evidence from the Classic suggests that the Long Count advanced at sunrise with the *haab*, we do not discount the possibility that it changed at sunset.

Also essential to Malmström's argument is the fact that Julian Day Numbers increment at noon GMT. This particular idiosyncrasy of the Julian Day Number system can be said to have introduced the potential for confusion into the discussion of the correlation, although the confusion actually enters into it with the perceived necessity of using Julian Day Numbers at all. In fact, it is quite possible to arrive at the correlation without them.

It bears pointing out that the system of assigning Julian Day Numbers, as well as a related concept called the Julian Date, is intended for precise recording of astronomical events and not as a means of correlating calendars. The Julian Date of any moment in time is the Julian Day Number for the preceding noon plus the fraction of 24 hours that has expired since then, with that fraction expressed as a decimal. For example, the Poco Uinic eclipse was at its maximum on the Julian Date 2009802.33 (John Justeson, personal communication 2012).

Thus astronomers tell us precisely when the eclipse began at the meridian of Poco Uinic. They express this using Julian Day Numbers, but that is simply one scale of measurement. We should not lose sight of the fact that the goal of the correlation is to be able to convert a given date in Maya chronology into its European calendar equivalent (Morley 1920:465). Thus it is equally correct to say that the eclipse began at the meridian of Poco Uinic shortly after sunset GMT on the calendar day July 16, 790 CE. The Stela 3 inscription tells us that the eclipse happened on Maya day 9.17.19.13.16. Therefore the Maya day 9.17.19.13.16 correlates to the European calendar day July 16, 790. The following day in the European calendar correlates to 9.17.19.13.17, while the previous Maya day 9.17.19.13.15 correlates to July 15, 790.[11] Anchored thus, we can extend the correlation in either direction by writing it out on a great many sheets of paper (taking care to account for leap years) or we can have a calculator do it for us. But we do not need Julian Day Numbers. After all, the correlation itself is between the Maya calendar and the European calendar, not between the Maya Calendar and the Julian Day Number system.

So why use Julian Day Numbers? Simply for convenience of reference and calculation. Astronomers assign one (and only one) Julian Day Number to a given European calendar date, so the JDN is a convenient identifier and computational referent, while correlation constants make use of the convenient JDN base date. For this reason scholars have talked of the correlation in terms

[10] Thompson seems to have had something of a blind spot about it. Although he was aware of the possibility that the *tzolk'in* changed at one time of day and the *haab* at another—anticipating Mathews in this regard—he deemed it likely that the Long Count changed with the *haab* at sunrise during the Classic (Thompson 1935:103). As we have seen, this means that the Long Count correlates with two different European calendar days (see for example Figure 7). Perhaps Thompson's reason for disregarding this consideration may be glimpsed in his candid reaction to ethnographic data from the Guatemalan highlands that the *tzolk'in* begins on one European calendar day and continues onto the next: "As this double dating is confusing [...] I shall not refer in future to the positions in our calendar on which a day may have entered, but that on which it was current" (Thompson 1950:303).

[11] This assumes that the Long Count changes with the *tzolk'in*, such that the correlation is exactly day-for-day. If, as is more likely during the Classic, it changed with the *haab*, the daytime portion of the Maya day correlates to one European calendar day while the nighttime portion correlates to the following one, as discussed above. This can be adjusted for without recourse to Julian Day Numbers.

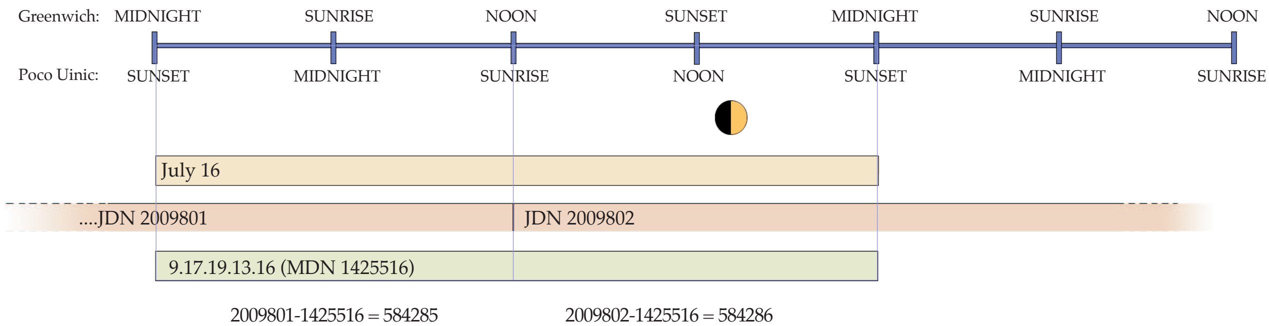


Figure 8. The Poco Uinic eclipse with the Long Count changing at sunset and the change of the Julian Day Number at noon represented, with the calculations arrived at by Malmström (1999).

of Julian Day Numbers and continue to do so. Hence we are obligated to understand them, particularly when they enter into a provocative analysis.

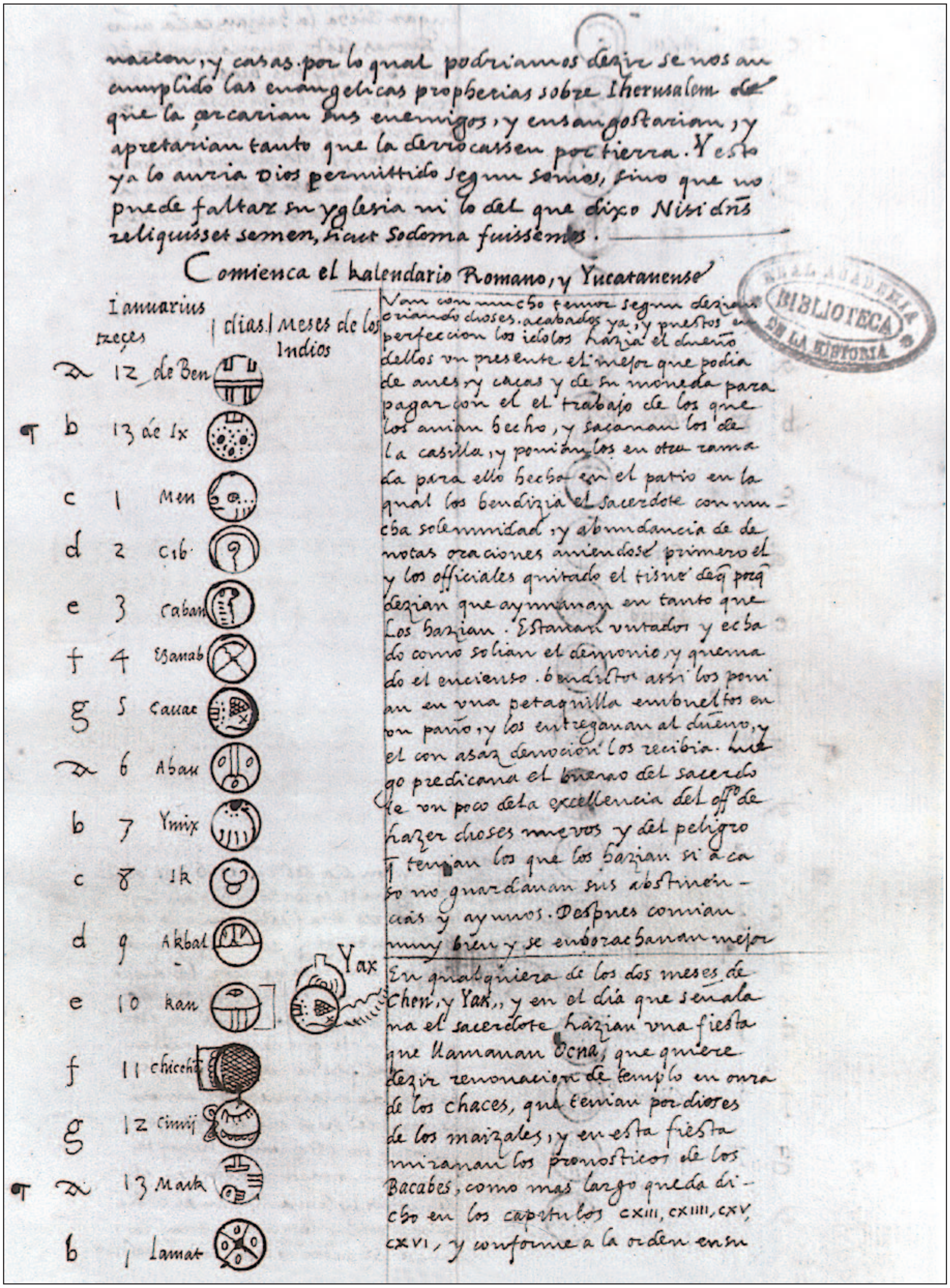
Malmström (1999) derives his two simultaneous correlations from the mathematics illustrated in Figure 8. This shows the Julian Day Number changing at noon such that (according to Malmström) Maya Day Number 1425516 can be subtracted from 2009801, the Julian Day Number of the previous day. This yields a correlation constant of 584285 for the portion of the Maya day between sunset and sunrise, while subtracting the same Maya Day Number from JDN 2009802 yields 584286 for the second half of the Maya day. Malmström concludes that "both Thompson's initial value (i.e., 584,285) and that implied by the inscription at Santa Elena Poco Uinic (584,286) are perfectly correct." But as Figure 8 makes clear, if the Long Count changes at sunset as Malmström would have it, then any event that happened on 9.17.19.13.16—be it between sunset and sunrise or sunrise and sunset—happened on July 16 in the European calendar. It is only if the Long Count changes with the *haab* at sunrise that two correlations are possible (see Figure 7) and then the lesser of the two correlations applies to the daylight hours and the greater to the nighttime (the opposite of Malmström's scenario).

So here at Poco Uinic we have what would appear to be the ideal situation: a correlation derived unambiguously from the inscriptions rather than postconquest historical documents. Yet as we have seen, Thompson rejected it because it was at variance with what he had already concluded from those postconquest documents. This was in the context of correlations derived from other inscriptions that also seemed to cluster within a few days of Thompson's 584285 or 584283. The fact that none of these was an exact match permitted Thompson to dismiss Poco Uinic's 584286 rather than revisit the assumptions underlying his own correlation.[12]

A fundamental assumption of Thompson's correlations is that Goodman (1905) was correct that the Long Count would have reached 11.16.0.0.0 in 1539 had it not fallen out of use by the time of the Spanish conquest. Extending this forward to the next 12 K'an 2 Pop (deemed equivalent to the 12 K'an 1 Pop given by Landa) reaches 11.16.13.16.4 in the year 1553. A related assumption is that it was in 1553 that, as recorded by Landa without specifying the year, 12 K'an 1 Pop coincided with July 16.

By way of background, the surviving manuscript of Diego de Landa's *Relación de las cosas de Yucatán* is an abridged version copied by unknown hands from a longer and now-vanished original (Gates 1937:69; Pagden 1975:18-19; G. Stuart 1988a, 1988b, 2007; Tozzer 1941:vii-viii). In it Landa sets out a description of the Maya months and their observances, accompanying this with a "Roman and Yucatec Calendar" (Figure 9). This juxtaposition (or correlation) of the European and Maya calendars starts out with New Year's Day in the European, which is partway through the month of Ch'en in the Maya, and advances day by day through the Maya months from that point until it reaches the *tzolk'in* before 12 K'an 1 Pop. This is numbered as 12 (Lamat), which cannot be the *tzolk'in* before 12 K'an but would in fact be the last day of a year beginning 12 K'an 1 Pop. Evidently what happened is that Landa started out with a Maya calendar created for him by one of his informants that began quite properly on Maya New Year's Day 12 K'an 1 Pop, in the first month of the Maya year. This would have fallen in a given July in the European calendar. Then it continued through until the last day of the Maya year, which would have reached the following July. Probably from a different informant Landa had determined that Maya New Year's Day was July 16 in his own calendar, so when he decided to start his juxtaposed calendars with January 1, he transposed that portion of the Maya calendar corresponding to

[12] On the other hand, Lounsbury (1978:809) at one time felt that 584285, "preferably increased by yet another day"—to 584286—was more "consistent with the interpretation of moon ages and of dates in the eclipse table" of the Dresden Codex than any other correlation in the Goodman-Martínez-Thompson family.



naçion, y casas. por lo qual podriamos dezir se nos an
cumplido las evangelicas propheçias sobre Iherusalem de
que la çercarian sus enemigos, y ensangostarian, y
apretarian tanto que la derrocassen por tierra. Y esto
ya lo avria Dios permittido segun somos, sino que no
puede faltar su yglesia ni lo del que dixo Nisi dns
reliquisset semen, sicut Sodoma fuissemus.

Comiença el kalendario Romano, y Yucatanense

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Ianuarius treçes	dias	Meses de los Indios
a 12 de Ben		
b 13 de Ix		
c 1 Men		
d 2 Cib		
e 3 Caban		
f 4 Ezanab		
g 5 Cauac		
a 6 Ahau		
b 7 Ymix		
c 8 Ik		
d 9 Akbal		Yax
e 10 Kan		
f 11 Chicchan		
g 12 Cimij		
a 13 Manik		
b 1 Lamat		

Van con mucho temor segun dezian
criando dioses. acabados ya, y puestos en
perfeccion los idolos hazia el dueño
dellos un presente el mejor que podia
de aves, y caças y de su moneda para
pagar con el el trabajo de los que
los avian hecho, y sacavan los de
la casilla, y ponianlos en otra rama
da para ello hecho en el patio en la
qual los bendizia el sacerdote con mu-
cha solemnidad, y abundancia de de
votas oraciones aviendose primero el
y los officiales quitado el tizne deq porq
dezian que ayunavan en tanto que
los hazian. Estavan untados y echa
do como solian el demonio, y quema
do el encienso. bendictos assi los poni
an en una petaquilla embueltos en
un paño, y los entregavan al dueño, y
el con asaz devocion los recibia. lue
go predicava el buenao del sacerdo
te un poco dela excellencia del offo de
hazer dioses nuevos y del peligro
q tenian los que los hazian si aca
so no guardavan sus abstinen-
cias y ayunos. Despues comian
muy bien y se emborrachavan mejor

En qualquiera de los dos meses de
Chen, y Yax, y en el dia que señala
va el sacerdote hazian una fiesta
que llamavan Ocna, que quiere
dezir renovacion de templo en onra
de los chaces, que tenian por dioses
de los maizales, y en esta fiesta
miravan los pronosticos de los
Bacabes, como mas largo queda di-
cho en los capitulos cxiii, cxiiii, cxv,
cxvi, y conforme a la orden en su

Figure 9. Underneath the heading *Comienca el kalendario Romano y Yucatanense*, "Here begins the Roman and Yucatec calendar," the first word on the left is *Ianuarius,* "January," indicating that the correlation of calendars starts with January 1 in the European calendar, which is partway through the month of Ch'en in the Maya. The next month after Ch'en is Yax, and the word "Yax" and its glyph can be seen partway down the column headed *Meses de los Indios*, "Months of the Indians." The other column headings are for *treçes*, "thirteens" (for the thirteen coefficients of the Maya *tzolk'in* calendar) and "*dias*" (for the days of the *tzolk'in* and their glyphs). The first row under the column headings starts with a letter representing the day of the week in the European calendar (a repeating series of seven, A–g), then "12 of Ben," i.e., 12 Ben 10 Ch'en. Photograph by George Stuart of folio 34r of the original document in the Real Academia de la Historia, Madrid.

January 1 through July 15 and put it in front of 12 K'an 1 Pop (Gates 1937:69; Spinden 1924:86; Tozzer 1941:151). Landa had some familiarity with the workings of the Maya calendar but obviously not enough to know that its interlocking mechanics do not permit treating successive years as identical. Clearly there were times when he was operating on his own without benefit of advice from his informants.

It is the repeating series of letters "A" through "g" in the left column of Figure 9 that led to the conclusion that 12 K'an 1 Pop fell on July 16 in the year 1553. Spinden (1924:85-86) writes:

> In connection with the orderly presentation of the days in the Maya tzolkin occupying stated positions in Mayan and European months, Landa gives a cycle of seven letters which correspond to the days of the week, Sunday being marked with a capital A and the other days by the lower case letters b–g. The year-bearer 12 Kan has the letter A and therefore corresponds to Sunday, July 16, 1553.

Spinden goes on to describe the manipulation by which Landa started with a Maya calendar running from July 16, 1553 to July 15, 1554 and rearranged it by a "cutting and patching process" so that it ran from January 1 to December 31, 1553. He concludes that "the week day letters disclose the fact that a Mayan year 12 Kan, July 15, 1553 to July 15, 1554, was set over against an almanac of the current European year 1553" (Spinden 1924:86).

Tozzer (1941:151) in turn quotes a letter from Martínez Hernández to Jean Genet:

> [...] Landa, in editing his typical year, began it January 1 with the Christian dominical letter A which means Sunday. At the time of the conquest the years 1525, 1553 and 1581 alone could have begun with Sunday. The Christian solar cycle is composed of twenty-eight years. During the first Landa was not in Yucatan and in the last he was already dead. It is, then, the year 1553 which he had in mind when it drew it up.

However, in an appendix to Thompson's own "Maya Chronology" (Thompson 1935), R. C. E. Long wrote:

> I think that there is no doubt that the year of Landa's calendar was 1553, having regard to the sequence of year bearers given in the Books of Chilam Balam and the Chronicle of Oxkutzcab, but Spinden's supposed demonstration that it must be 1553, because the first of January is marked with the letter A, proves nothing. In the Church Calendar every first January is marked A, the first of the series of seven "ferial" letters. If Sunday falls on A, the first of January, then the "dominical letter" for that year is said to be A, but this has nothing to do with the invariable series of seven ferial letters, which is all that Landa gives. (Long 1935:97)

More recent analysis of this topic by Baaijens (1995:51) concludes "that Landa's Calendar need not be made in 1553, and that if 1553 is right it must be proven from other sources."

Like Long in the quotation above, Thompson had little doubt that 1553 was the year of Landa's calendar. Although it does not rise to the level of a proof, there was confidence to be gained from the fact that Goodman's (1905) argument for placing 11.16.0.0.0 in 1539 accorded so well with Landa's date. But Thompson was well aware of the need to justify the assumptions on which his correlation was based. In the absence of confirmation from astronomy, he sought corroboration by aligning the correlation to the count of days kept into modern times in the Guatemalan highlands. He arrived at this alignment by the following steps, as illustrated in Figure 10.

Thompson followed Goodman in associating 12 K'an 1 Pop with a Long Count of 11.16.13.16.4 (Maya Day Number 1704204), a position that corresponds to 12 K'an 2 Pop in the Classic system. He subtracted this from 2288488, the Julian Day Number of July 16, 1553 to arrive at a correlation constant of 584284. (This was a mistake, as we will see; he should have arrived at 584285.)

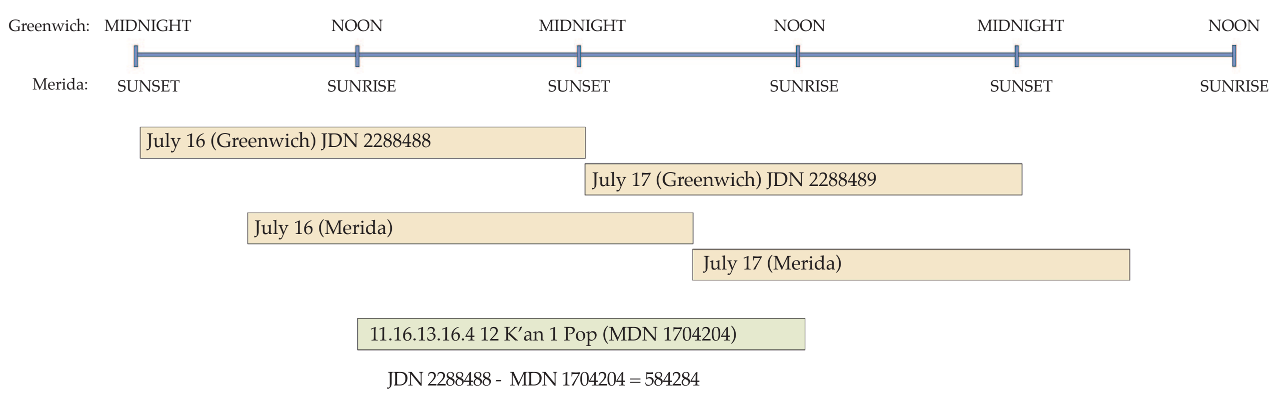

Figure 10. Maya New Year's Day in Merida, as conceived of by Thompson.
(July 16 in Merida is offset from July 16 in Greenwich because midnight in Merida is six hours later.)

Having arrived in this fashion at 584284, Thompson decided that this had to be adjusted by one digit in order to account for the month coefficient of 12 K'an 1 Pop being one less than in any inscription then known from the Classic. This suggested to Thompson that there had been a "break of a day" which had to be added back in. Then when he and Proskouriakoff encountered Calendar Rounds like 12 K'an 1 Pop in the Classic (Proskouriakoff and Thompson 1947), he was able to discard the "break of a day" hypothesis and with it the astronomically unprovable 584285.[13] He believed that he was now only one day away from a correlation that could be corroborated by something other than Colonial sources. Lincoln (1942) and La Farge (1947) had collected data from twentieth-century daykeepers in the Guatemalan highlands that supported a correlation of 584283, and La Farge had also suggested that the Aztec almanac aligned with this (Thompson 1950:304).

Previously Martínez Hernández (1926) had realized that the leap years of the European calendar could affect its correlation with the Maya sequence of Calendar Rounds. Thompson did not agree with the correlation that Martínez Hernández arrived at by invoking leap years, but he saw how the concept could be used to gain the necessary one-day adjustment of his own.

> There is a possible explanation of this one-day difference: Landa reached Yucatan in 1549; his calendar is securely dated as 1553, but it is extremely doubtful that Landa's native informant had enough knowledge of the European calendar to make the correlation of the two systems. It is possible, even probable, that Landa acquired before 1553 the information that the year bearers fell on July 16 (O.S.), and when he came to set his data against the European calendar, he utilized the information that he had gathered two or three years earlier, unaware of the fact that, because of the leap day in 1552, the position 1 Pop had moved from July 16 (O.S.) to July 15. (Thompson 1950:304)[14]

The table in Figure 11 shows how, based on a 584283 correlation, New Year's Day would have fallen on July 16 for the four years beginning with the leap year in 1548, then moved to July 15 with the leap year of 1552. Thompson's idea is that Landa's informant prepared a Maya calendar for the year in which 12 K'an 1 Pop fell in 1553, but he did not provide any European calendar equivalents to his dates (probably because he did not know them). Landa supplied these himself by simply correlating 12 K'an 1 Pop to July 16 and extrapolating the rest of the dates. According to Thompson's theory, Landa chose July 16 because it was in 1549, 1550, or 1551 that he asked a more knowledgeable native informant, "On what day of the Christian calendar does your New Year fall?"

Implicitly or explicitly, the majority of scholars have

11.16.4.13.19	3 Kawak	1 Pop	(17 July 1544)
11.16.5.14.4	4 K'an	1 Pop	(17 July 1545)
11.16.6.14.9	5 Muluk	1 Pop	(17 July 1546)
11.16.7.14.14	6 Ix	1 Pop	(17 July 1547)
11.16.8.14.19	7 Kawak	1 Pop	(16 July 1548)
11.16.9.15.4	8 K'an	1 Pop	(16 July 1549)
11.16.10.15.9	9 Muluk	1 Pop	(16 July 1550)
11.16.11.15.14	10 Ix	1 Pop	(16 July 1551)
11.16.12.15.19	11 Kawak	1 Pop	(15 July 1552)
11.16.13.16.4	**12 K'an**	**1 Pop**	**(15 July 1553)**
11.16.14.16.9	13 Muluk	1 Pop	(15 July 1554)
11.16.15.16.14	1 Ix	1 Pop	(15 July 1555)

Figure 11. The effect of leap years (in 1544, 1548, and 1552) on New Year's Day (1 Pop) in the Colonial-era Maya calendar. The European calendar dates are per the 584283 correlation. The Long Counts are in accordance with Thompson's (erroneous) assumption that the Long Count of 12 K'an 1 Pop was equivalent to that of 12 K'an 2 Pop in the Classic system.

accepted Thompson's leap-year argument (see, for instance, Bricker and Bricker 2011:91). That is why the idea has entered into the popular consciousness that the thirteenth Bak'tun will end on December 21, 2012, which is the date in the 584283 correlation, as opposed to December 23 in the 584285 correlation (or Christmas Eve, December 24, according to 584286).

Figure 12 illustrates 12 K'an 1 Pop falling on July 15, 1553, in accordance with Thompson's reasoning. Because he had discarded the "break of a day" but still did not understand the nature of a Calendar Round like 12 K'an 1 Pop, he continued to believe that it was equivalent to 12 K'an 2 Pop in the Classic system. Thus he associated the Long Count of 11.16.13.16.4 with the daylight hours of July 15 and arrived at a correlation of 584283.

However, with our better understanding of the Classic system we know that 12 K'an 1 Pop is the type of Calendar Round that falls at sunset (or at any rate after dark). That the *tzolk'in* changed at sunset—and by Landa's time the entire 24-hour day did so as well—is born out by the findings of Lincoln (1942) and La Farge

[13] Bricker and Bricker (2011:94-99) discredit Lounsbury's attempt to test 584285 against the eclipse tables of the Dresden Codex. They conclude that the 584285 correlation "cannot, in fact, be justified on epigraphic, ethnohistoric, or astronomical grounds" (Bricker and Bricker 2011:99).

[14] The abbreviation "O.S." ("Old System") refers to the Julian calendar used in Landa's time. Except as noted, Thompson gives his dates in the Julian calendar's successor, our current Gregorian, which can be adjusted to the Julian by adding ten days (thus the "Landa date" is July 26 in the Gregorian calendar).

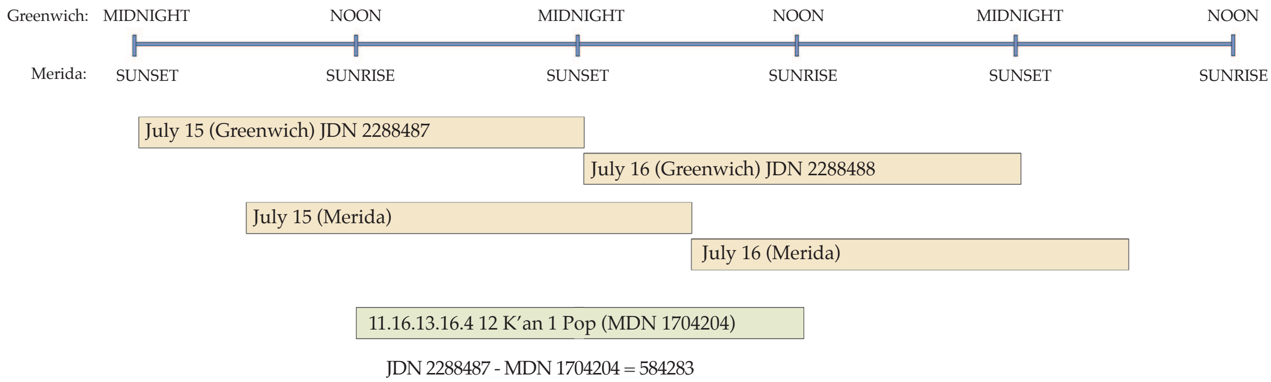

Figure 12. Maya New Year's Day in Merida falling on July 15, 1553, as conceived of by Thompson.

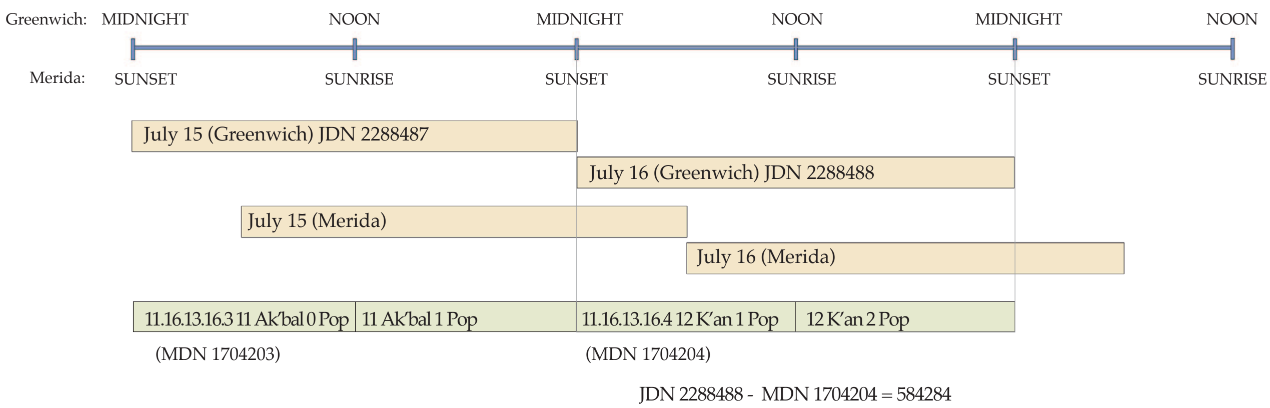

Figure 13. The Classic system (with the Long Count changing at sunset) extended to July 15, 1553.

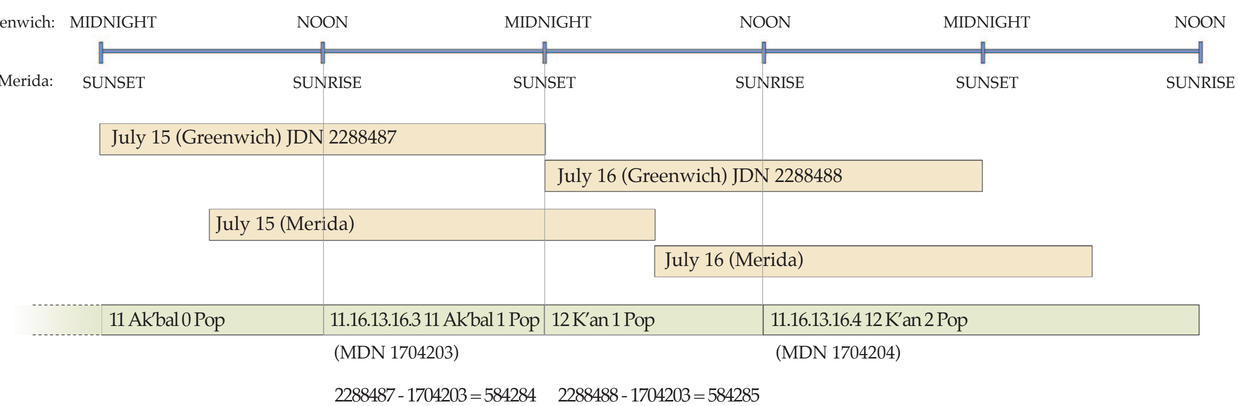

Figure 14. The Classic system (with the Long Count changing at sunrise) extended to July 15, 1553.

(1947) that the day begins at sunset in the continuing Maya tradition of the modern highlands (see Thompson 1935:103). Sunset in the Maya region is midnight in Greenwich. Thus when we extend the Classic system to July 15, 1553 and show the Long Count changing with the *tzolk'in* (one of the two possibilities), 12 K'an 1 Pop corresponds to the next European calendar day, July 16, as illustrated in Figure 13. Here the entire day numbered by the Long Count of 11.16.13.16.4 overlaps with July 16 in Greenwich, such that only a single correlation can be derived: 584284.

Figure 14 shows the other, more likely possibility for the Classic system, where the Long Count changes with the *haab* at sunrise. As we saw at Poco Uinic, two correlations are possible: in this case, 584284 for the hours between sunrise and sunset and 584285 for the hours between sunset and sunrise the following day.[15]

Thus 584283 cannot be reached even in Thompson's leap-year scenario. The correlation is still one day off from the highland calendars.[16] And without corroboration from the highland data, even Goodman's basic 11.16.0.0.0 correlation remains unproven after more than a century.

Fortunately there is a way forward out of this impasse. While astronomy has not confirmed Thompson's correlations derived from the Landa's information, it does support 584286, and this correlation can be shown to be consistent with Landa. Following Thompson (1950:304) as quoted above, we believe that it was Landa himself who juxtaposed the European calendar with the Maya calendar that had been set down for him in 1553 by one of his informants. We have seen for ourselves that Landa manipulated the Maya calendar on his own, without benefit of a native informant to tell him that Maya years are not identical (except on a 52-year cycle). The informant who created the Maya calendar for Landa was not asked to tie the European calendar to it—Thompson doubts that he would have been able to do so. We follow Thompson in finding it plausible that it was another informant at another time who answered Landa's question, "On what day of the Christian calendar does your New Year fall?" We suggest that the other time in question was any of the years 1556, 1557, 1558, or 1559, when the answer would have been the 16th of July. Figure 15 shows that Maya New Year's Day would have fallen on July 16 in all four of those years in the 584286 correlation. In the previous four, including 1553, it had fallen on July 17.

11.16.12.15.18	11 Kawak	1 Pop	(17 July 1552)
11.16.13.16.3	**12 K'an**	**1 Pop**	**(17 July 1553)**
11.16.14.16.8	13 Muluk	1 Pop	(17 July 1554)
11.16.15.16.13	1 Ix	1 Pop	(17 July 1555)
11.16.16.16.18	2 Kawak	1 Pop	(16 July 1556)
11.16.17.17.3	3 K'an	1 Pop	(16 July 1557)
11.16.18.17.8	4 Muluk	1 Pop	(16 July 1558)
11.16.19.17.13	5 Ix	1 Pop	(16 July 1559)

Figure 15. The effect of the leap years in 1556 on New Year's Day (1 Pop) in the Colonial-era Maya calendar. The European calendar dates are per the 584286 correlation. The Long Counts are based on the assumption that the Long Count changed with the *haab* in the Classic period.

Figure 16 shows the effect of extending the Maya Long Count forward from the date of the eclipse at Poco Uinic to July 17, 1553. This results in a correlation of 584286 in the scenario where the Long Count aligns with the *tzolk'in*. Figure 17 shows it aligning instead with the *haab*, in which case two correlations are possible: 584286 for the hours between sunrise and sunset, and 584287 for the hours between sunset and sunrise.

That Maya New Year's Day fell on July 17 in the year 1553 is attested by another important Colonial-era source. Pedro Sánchez de Aguilar, grandson of one of the first Spanish colonists of Yucatan, wrote a book arguing for the legal rights of the priesthood in the suppression

[15] Bricker and Bricker (2011:77-99), who support the 584283 correlation, hold that 12 K'an 1 Pop is equivalent to 12 K'an 2 Pop in an alternative calendar system (that of Mayapan), and both are to be associated with the Long Count 11.16.13.16.4. Adhering to Thompson's leap-year argument, they hold that 12 K'an 1 Pop fell on July 15, 1553. Bricker and Bricker present evidence that the Classic system of counting *tzolk'ins* has been preserved unchanged in the modern-day Maya highlands of Guatemala. In that living tradition, as we have seen, the day begins at sunset (La Farge 1947; Lincoln 1942). It follows that the Maya New Year's Day recorded by Landa began at sunset in Merida, which is midnight in Greenwich and the beginning of a new European calendar day. Thus the Long Count 11.16.13.16.4 must be subtracted from a Julian Day Number one digit higher to yield a correlation of 584284 rather than 584283.

[16] Nor is it possible to invoke a second leap year to bring them into alignment. To say that Landa got his New Year date before the leap year in 1548 is not tenable because Landa did not arrive in Yucatan until 1549.

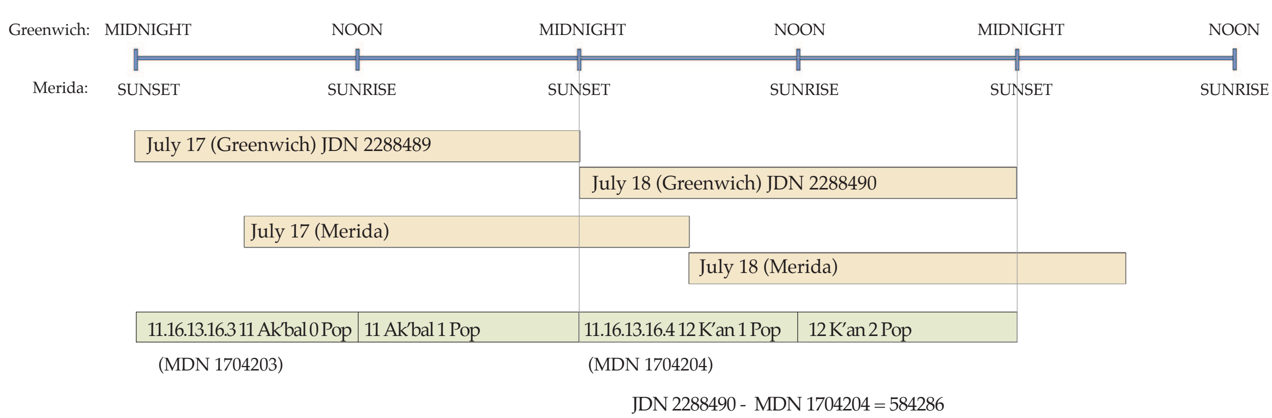

Figure 16. The Classic system (with the Long Count changing at sunset) extended to July 17, 1553.

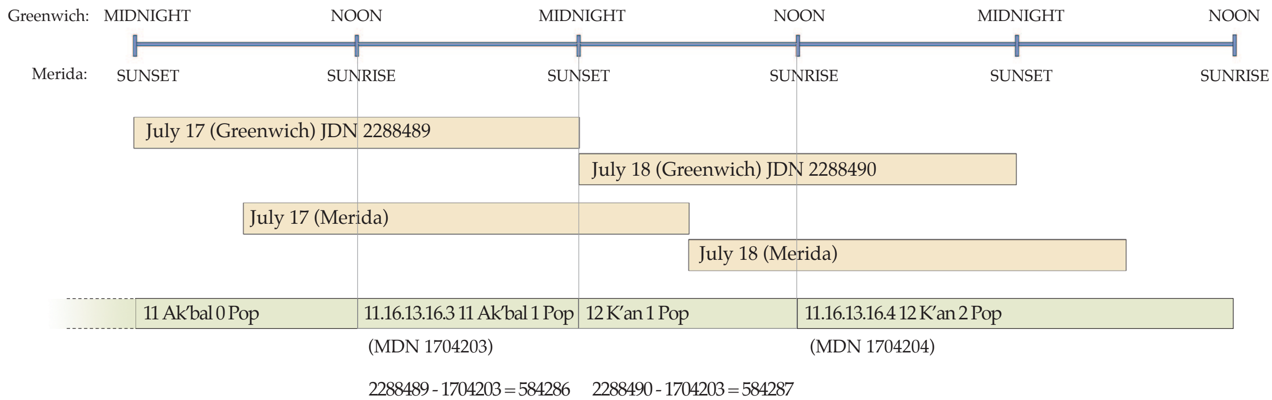

Figure 17. The Classic system (with the Long Count changing at sunrise) extended to July 17, 1553.

of idolatry in which he interspersed observations on native customs (Houston et al. 2001:39). Thompson (1950:307) considered him to be "an independent source for the Maya year's having started with the first of Pop in mid-July." Sánchez de Aguilar was more specific than that: he wrote that the first of Pop corresponded to "17th of July" (Sánchez de Aguilar 2001[1639]:39).

The premise motivating this paper is that if a solar eclipse is set to 9.17.19.13.16 5 Kib 14 Ch'en on Poco Uinic Stela 3—and we hope to have bolstered the epigraphic case for that interpretation—then neither of the currently favored 584283 or 584285 correlations can be correct. The only value that would connect the Classic Maya and European calendars would be 584286. This much has been appreciated since the 1930s, but the idea has failed to gain any support because it seemed consistent neither with modern-day highland calendars nor the evidence left to us by Landa. What we suggest here is that the modern highland count of days cannot be made to correlate with the Classic inscriptions and that Landa can be understood within a 584286 correlation. If we have successfully demonstrated a proper understanding of Classic Period calendrics in this study then only a 584286 correlation is possible and there is no discrepancy between the Classic and Colonial sequence of days.

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