NON REGULAR VARIATIONS IN THE LOD FROM EUROPEAN MEDIEVAL ECLIPSES

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ABSTRACT. The study of ancient eclipses has demonstrated its utility to approximate some astronomical constants, in particular in the field of the Earth's rotation. It is a well known fact that the rate of rotation of the Earth is slowly decreasing in time. There are many possible reasons for this fact, including internal and external mechanisms. The most important external causes are lunar and solar tides. While internal causes can be very diverse: examples of short term effects are changing wind patterns, electromagnetic coupling between the fluid core of the Earth and the lower mantle, while sea-level fluctuations associated with climatic variations are examples of long time effects. In any case, the most important cause is the tidal friction.

The visibility for a solar eclipse depends mainly on the position of the observer on the Earth's surface and on the position of the Moon and Sun in space. If we use the uniform Earth's rotation rate, we realize that the computed eclipse conditions do not correspond with the observed ones, in general. The computed eclipse path will be shifted westwards from the place of observation proportionally to the latitude of the central line of totality (in some cases, annularity). To make the calculations coincide with the observed eclipse, one has to apply a correction corresponding to the angular difference in geographical latitude.

ΔT value is needed not only for the calculation of exact times of an eclipse or occultation, but also for determining the position of the central line or the zone of visibility. A value $\Delta T = 3600$ s is roughly equivalent to a shift of 15° in longitude. Past values of ΔT can be deduced from historical astronomical observations such as ancient eclipses which have been widely studied by F.R. Stephenson [2], [3] who obtained an approximation formula for the values of ΔT in the range between -500 and +1950. This approximation is nowadays widely used in astronomical calculations.

The derived relative error from ΔT obtained from ancient eclipses is quite large, mainly because of the large width of the totality zone and the inaccuracy in the definition of the observational place. A possibility to partially solve these former problems is the analysis of total eclipse records from multiple sites, which could provide a narrow parameter range. In addition, conjunct analysis of these astronomical phenomena is useful for determining a range of ΔT in function of the tidal acceleration of the Moon

1. DETERMINATION OF ΔT AND THE TIDAL ACCELERATION VALUE

In the study of the variation of the Earth rotation using untimed observations of total eclipses, the precision of the ΔT obtained values depends mainly on the width of the totality band and on the precise definition of the observational places. The analysis of the eclipse observed from multiple sites provides a more precise measure for the former value. In addition, there is the possibility of including also the conjunct determination of ΔT and the variation of the tidal acceleration of the lunar motion.

We implicitly assume that the motion of the Moon is accurately known. In fact, this is true if we consider only the period of time covering the last decades, partly as a consequence of the use of modern techniques, such as LLR. Nowadays, we are aware of the existence of two highly correlated quantities: ΔT and the tidal acceleration of the Moon. The usual procedure deals only with the ΔT but in [1], and following the work of other authors ([2], [3] and [4]), we chose three particular eclipses from the XIIIth and XIVth century, all of them observed in Europe and we have obtained the ranges for ΔT for different values of the tidal acceleration. The inclusion in the study of other almost contemporary eclipses should provide an even narrower range of ΔT for each of the values of the tidal acceleration and could help to

identify redundant or inconsistent observations.

2. PRELIMINARY RESULT FOR THE XIIIth AND XIVth CENTURIES

In the period between AD500 and the telescopic era numerous Moon and Sun eclipses have been recorded in Europe, especially after AD1000. In most cases, the observations were arranged in a 'professional' way, in the sense that the date and the instant of the day when the eclipse occurred were accurately reported, but in other cases, they were only roughly estimated.

In Figure 1 we can see a preliminary study based on the available data of eclipses observed in Europe between the XIII and the XIV centuries. The period of time covers from 1190 to 1410. The original number of observations from several sources was over 40, but we disregarded all the partial Sun eclipses. A total amount of 25 observations have been collected and analyzed, regarding special attention to those eclipses viewed from multiple sites.

The regression line has been obtained and compared to that obtained by Stephenson, showing a great agreement. However, further computations should be arranged, taking into account other historical data for the epoch, such as occultations or Lunar Eclipses. In addition, the consideration of suitable weights should be considered.

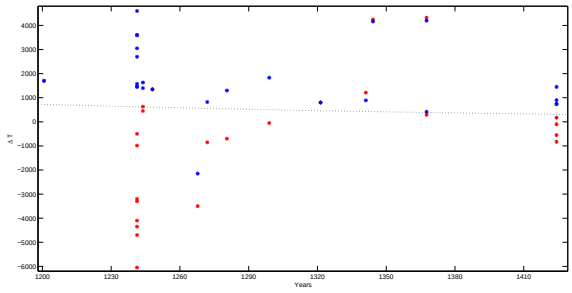

Figure 1: Preliminary study of the available data covering the XIII and the XIVth centuries. The * represent the limit values for the range of the ΔT value at each observational place, the dashed line represents the approximated values obtained by [2] for the ΔT

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3. REFERENCES

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