A Note on a Possible Optic–Atmospheric Phenomenon in the Iberian Peninsula in the 13th Century

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Historical documents that provide information about climate are tools that must be used by climatologists in their studies about past climate. Nevertheless, these historical sources are difficult to find and must be interpreted with caution. In this aspect, the Iberian Peninsula is a privileged zone because important cultures have emerged in it. These cultures have left a rich historical and documentary heritage that has not been investigated yet from a climatic point of view.

Another interesting aspect is related to the impact that meteorological phenomena caused in great historical events. We can point out some interesting examples as Mongol Invasions of Japan (Neumann, 1975), Crimean War (Lindgrén and Neumann, 1980), and the Battle of Trafalgar (Wheeler, 1985, 1987).

This study is aimed at the analysis of a possible atmospheric phenomenon that happened in the Iberian Peninsula in the 13th Century. This claimed our attention from the beginning because of its similarity with Joshua's miracle, the atmospheric nature of which has been analyzed by Camuffo (1990a). This phenomenon was greatly discussed by some authors (Elomaa, 1990; Camuffo, 1990b). Moreover, the possible atmospheric phenomenon that we are going to analyse is related to an important historical event: the Christian conquest of Seville.

An ancient Spanish legend narrates one of the more fantastic episodes of the "Reconquest" of the Iberian Peninsula. During this epoch, Christians fought against Arabians, who stayed in the Iberian Peninsula for eight centuries (711-1492). During one of the regular skirmishes, Christians routed their enemies. Nevertheless, the Sun was going to set immediately and, for that, the struggle would finish without a total Christian victory. The Christian officer in command, the Master of the Order of Santiago, prayed to the Virgin Mary for stopping the Sun. He shouted: "Detén tu día" (Stop your day). The miracle was produced, the day was extended until the Christians defeated the Moslems and that place was called "Tentudía". There are several written references to the phenomenon. The oldest one is *Primera Historia de la Orden de Santiago* (Orozco and Parra, 1978), which is a manuscript from no later than 1488. The phenomenon is reported by very different authors

(Ver Alaba, 1655; Rivadeneyra, 1599–1601; Pineda, 1627; Ortiz, 1677; Mariana, 1950; Coria, 1608; Rades Andrada, 1980; Caro de Torres, 1629).

There is no reference about the exact date of the phenomenon. Historians date the episode about 1248, when the Christian king Fernando III conquered Seville City (Terrón Albarrán, 1986, Tome I, pp. 459-464). The place where the phenomenon was observed is located in the Iberian Peninsula, in the nearby Tentudía hills (38º 1' N, 6º 18' W). Tentudía Mountain is 1110 m height (the highest peak of Badajoz province).

Establishing the nature of the phenomenon is not an easy result due to the temporal distance of the event and the kind of description about it that is possessed. In fact, this is a legendary event and it is very difficult to separate the reality and the fiction. Terrón Albarrán (1986, p. 461) try to know from the earliest sources the true historical facts and the legendary aspects. In any case, the Tentudía case presents great similarities with that analyzed by Camuffo (1990a). There are several opinions about the nature of the phenomenon reported by Camuffo. The main two options are the meteorological and the astronomical origin of the phenomenon. According to Camuffo (1990a), the event occurred at sundown, after an exceptional hailstorm, which left the ground of the valley where an army stayed covered with ice. This resulted in a big drop in the air temperature, forming the conditions for a "superior mirage". The other army was in another nearby place, untouched by hail, on hot soil, in the usual daytime conditions of "inferior mirage". When they reached the place of the enemy, their optical path inverted curvature, displacing upwards the sun, which was setting. On the other hand, Elomaa (1990) comments that a large comet must have passed very near to our planet and disrupted its movement; a part of the stones dispersed in the neck and tail of the comet smote the surface of our earth a shattering blow. Venus was that comet, and it became a planet in historical times. Camuffo (1990a) replies that Elomaa's comments was certainly fascinating, but unfortunately were based on an unrealistic hypothesis –Venus was a comet– that has never been accepted by astronomers.

In the case of Tentudía, the astronomical explanation is more unlikely. An astronomical anomaly would have been reported in numerous studies all around the world. However, there is no comet reported which would have been seen in the Iberian Peninsula around 1248. Yeomans (1991) reported comets in 1240, 1242, 1245, and 1264. Only those that happened in 1240 and 1264 could have been seen from Europe. No comets around 1248 are reported in the Arabian sources either (Vaquero et al., 2000). Therefore, the meteorological nature seems to be the most realistic explanation despite the fact that the hail is not mentioned in the narrations of the episode of Tentudía.

In order to illustrate how the length of a day (ΔH) can be increased for different supposed positions of the sun, Figure 1 has been displayed. This figure shows examples of the increase of the duration of the day if one observes the sunset when the real position of the Sun is 10°, 5º or 1º under the horizon for a place located at 38° N of latitude. This increase of the duration of the day would vary, depending on the season of the year, between 50 and 58 minutes approximately for an astronomical height h=-10º, between 25 and 29 minutes for h=-5º, and between 5 and 6 minutes for h=-1º. These assumptions have been made according to the following expression:

$$\Delta H = \frac{-h\cos h}{\cos\varphi\cos\delta\sin H},$$

where ΔH is the increase of the duration of the day, h the astronomical height, φ the latitude of the place, δ the astronomical declination, and H the hour angle.

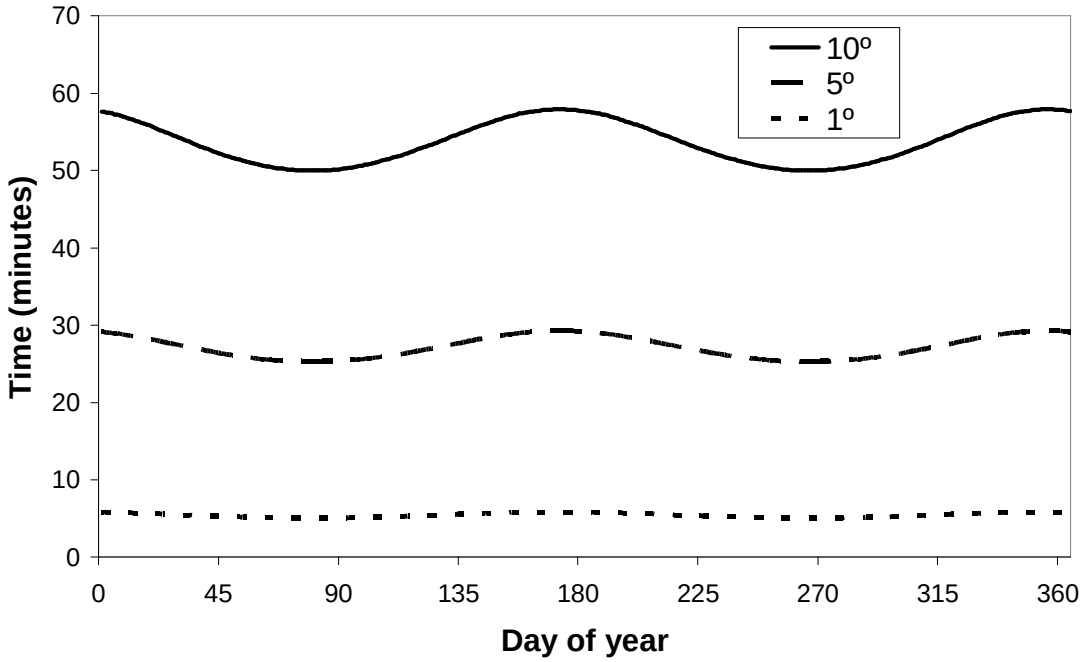

Figure 1. Increase of the duration of the day.

In order that this kind of phenomena were produced in nature the atmospheric conditions must be really extraordinary. One could think about the existence of the meteorological conditions that provoke a great storm: the ground warming due to solar radiation, convective cells that induce the formation of cumulonimbus and the subsequent storm due to the prevailing atmospheric instability that will induce a negative temperature gradient with the height near the ground due to the possible evaporation of the rain droplets. Under these conditions, taking into account the atmospheric refraction with the sun below the horizon, an observer over the ground can receive a ray of light that has passed through an atmospheric wave-guide produced by the extraordinary atmospheric conditions. The observer continues seeing the sun after the sunset with the subsequent extension of the day's light.

This meteorological origin can explain the lack of other reports of the phenomenon, since it has to do with local atmospheric conditions. This episode gives strength to the meteorological nature of similar phenomena, one being that reported by Camuffo.

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