

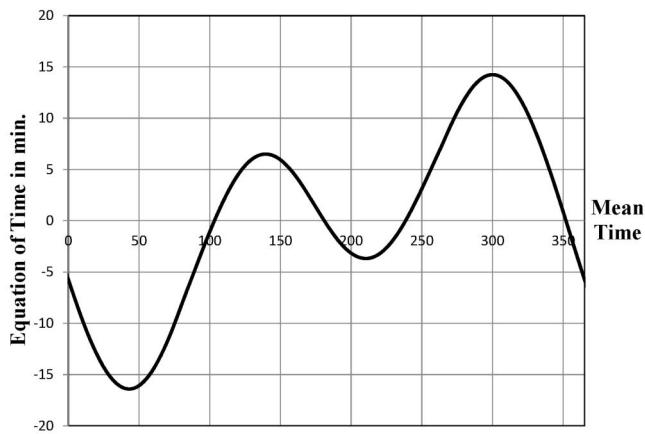


Fig. 6. Equation of Time vs Mean time.

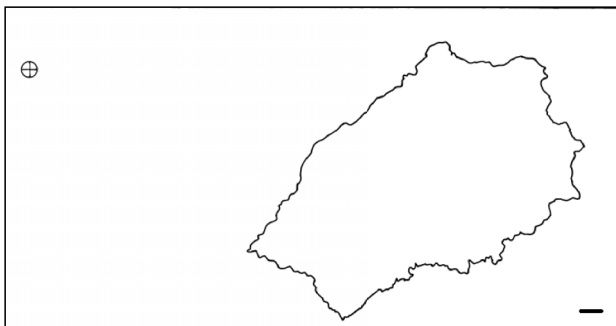


Fig. 7. The estimated position by use of Towneley data and the real position of the island; the bold bar corresponds to 1 km for Figs. 7–9.

(6) Evaluate the equation of time by

$$M - \pi + \varpi - V.$$

(7) Repeat (1)–(6) for all year around.

Figure 6 shows EOT in min plotted against 365 days from January to December (see Appendix for parameters used).

Now you can establish the local time with your observation by a sundial and correction due to the equation of time.

2.2 Edmond Halley's observations in the island of St Helena

He left Downs on 3rd December 1676 and arrived at the island in March 1677. He charted the southern stars. He left the island in March 1678 and arrived at England in May. He published the results of his expedition as 'Catalogus Stellarum Australium' in 1679 [2]. On its title page Halley states 'the island of St Helena (Latitude: $15^{\circ}55'$ S; and Longitude: 7 degrees west from London).' The rare celestial events are useful to determine the longitude. That is the transit of Mercury on 7th November 1677. Halley observed the ingress and the egress.

There are two European observations about the same transit. In Towneley, England, Richard Towneley (1629–1707) observed the egress [3]. In Avignon, France, Jean Charles Gallet observed almost all the process [4]. In all the observations we learn only data on the exterior contact of the egress, the emersion, are common. We make use of the today's longitudes of Towneley Hall and St Symphorien Church. The raw data are as follows:

//time of emersion//	//longitude//
*Avignon $15^{\text{h}}26^{\text{m}}56^{\text{s}}$	$4^{\circ}48'46''$ E
*Towneley $14^{\text{h}}56^{\text{m}}36^{\text{s}}$	$2^{\circ}13'21''$ W
*St Helena $14^{\text{h}}41^{\text{m}}54^{\text{s}}$	'to be determined'

Translating the time difference into the longitude difference, we determine the longitude of St Helena:

$6^{\circ}26'44''$ W by use of Avignon data;

$5^{\circ}53'21''$ W by use of Towneley data.

The latter is better, but this estimate points the place one island away from St Helena. The clock of Avignon gains two minutes or so.

2.3 Nevil Maskelyne's observations in the island of St Helena

He left Portsmouth on 17th January 1761, and arrived at the island on 6th April. He failed to observe the transit of Venus on 6th June. The malfunction of his zenith sector let him abandon the annual observation of Sirius. He left the island on 19th February 1762, and arrived at Downs on 7th June.

He had systematically examined the lunar distance method on both ongoing and return voyages. On the way to the island he also tried the common reckoning. He published all these efforts as 'British Mariner's Guide' in 1763 [5]. In this book Maskelyne states 'the longitude, by the common reckoning, was $1^{\circ}28'$ east of London.' Thus the common reckoning misleads us to the disastrous result, as we mention above. The cloudiness of the island also annoyed Maskelyne. He could observe the Moon's culmination only once, so he abandoned to use the lunar distance method to determine the longitude of the island. Instead he observed eclipses of Jupiter's satellites, and he arrived at the conclusion: $5^{\circ}49'$ west of Greenwich [5]. Maskelyne determined the latitude to be $15^{\circ}55'S$.

Our exercise makes use of the lunar eclipse on 18th May 1761. Nevil Maskelyne [6], Mason and Dixon at the Cape of Good Hope [7], and Peter Wargentin at Stockholm [8] recorded the emersion and the end of eclipse in common:

//location//	//emersion//	//end of eclipse//	//longitude//
*St Helena	$10^{\text{h}}39^{\text{m}}23^{\text{s}}$	$11^{\text{h}}46^{\text{m}}52^{\text{s}}$	to be determined
*Cape	$12^{\text{h}}15^{\text{m}}37^{\text{s}}$	$13^{\text{h}}23^{\text{m}}42^{\text{s}}$	$1^{\text{h}}13^{\text{m}}35^{\text{s}}$ E
*Stockholm	$12^{\text{h}}15^{\text{m}}00^{\text{s}}$	$13^{\text{h}}21^{\text{m}}08^{\text{s}}$	$1^{\text{h}}12^{\text{m}}01^{\text{s}}$ E

Taking the mean of two chances, we determine the longitude of St Helena:

$5^{\circ}44'15''$ W by use of Cape data;

$5^{\circ}53'55''$ W by use of Stockholm data.

The estimate by Cape is pretty good, but the mean of these gives us

$5^{\circ}49'05''$.

This is much the same as Maskelyne's estimation. The estimated position is the place half an island away from the real position.

2.4 Manuel J. Jonson's observations in the island of St Helena

In 1823 Johnson came to the island as Lieutenant of the East-India Company Artillery. The Governor and General Alexander Walker ordered Johnson to establish an astronomical observatory, and he founded it on Ladder Hill in