Let's Get the Number Right—Close!

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The means and opportunity to observe a total eclipse of the Sun [TSE] is rare. This is one of the reasons we do not want people to miss the 8 April TSE, which will pass over a large population in North America. To make our point, it is tempting to say something like, “Only \( F \) people see a TSE is their lifetime.” But what is the fraction \( F \)? Google provides an answer, and that answer is something like “one out of ten thousand” (without attribution). If our goal is merely order-of-magnitude, then a simple calculation shows that this cannot be correct.

Let,

\[
\begin{align*}
F &= \text{fraction of people who observe a TSE} \\
P &= \text{human population} \\
H &= \text{average human lifetime} \\
E &= \text{surface area of the Earth} \\
L &= \text{average TSE path length} \\
W &= \text{average TSE path width} \\
T &= \text{average number of TSEs per year (converges to)} \\
C &= \text{average global cloud cover}
\end{align*}
\]

Assumptions:

 tỏ Eclipse path overlaps are ignored. 
 צורך Latitude and longitude effects, which would turn straightforward algebra into a problem in spherical trigonometry, are ignored.

I realize that \( P \) includes, for instance, infants. However, the portion of a human lifetime during which a person is physically incapable of observing a TSE is usually small.

The number of people who stay home to observe a TSE is much greater than the number who travel in order to do so.

While it is possible to see a TSE through thin clouds, I take “cloudy” equal to “cannot see.”

This is key: The mean population density of the Earth is 13.1 per square kilometer. (An argument can be made for using the median, a less accessible figure.) The number who observe a TSE in the oceans—most of the Earth’s area—is very close to zero. Still, I feel that it is legitimate to say that at least one person per square kilometer wants to observe a TSE, is not precluded from doing so by circumstance, and is healthy enough to do so. You may disagree, but remember: This is an order-of-magnitude calculation.

So, what is \( F \)?

\[
F = \frac{TLWHC}{EP}
\]

\[
F = \frac{(2/3 \ y^{-1})(15,000 \ km)(480 \ km)(73.4y)(2/3)}{(5.10 \times 10^8 \ km^2)(8.0 \times 10^9)}
\]

\[
F \approx 10^{-10} !
\]

What if I have erred by as much as an order of magnitude in each of my estimations for the more approximate variables, say \( L, W, \) and \( C \)? And have done so that the error increases \( F \)? I still cannot reach \( 10^{-3} \). The chance to observe a TSE from one’s backyard, school, place of work, or community gathering spot is very fortuitous. Spread the word!