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The hottest year on record

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Suppose that a weather recording station started operations in 1871 and has complete records from then onwards. These may well include the noon temperature on each day. The mean noon temperature for any year may then be calculated.

[The details in the first paragraph are scarcely relevant to this note. In fact systematic recording and preservation of weather data generally started in the second half of the nineteenth century. The same discussion applies to other weather statistics such as the total rainfall in October of each year.]

The data preserved by the weather station may be used to determine which years since 1871 were the hottest (in the sense of mean noon temperature) on record. Of course 1871 would be such by default. Assuming general climate stability 1872 has probability $1/2$ of being the hottest on record, 1873 has probability $1/3$, 1874 has probability $1/4$ and 1950 has probability $1/80$. So the expected number of hottest (in this sense) years on record is

$$\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \cdots + \frac{1}{80} \approx 4.97$$

In practice weather records of that era tend to have around five 'hottest on record' years. This is evidence of the relative stability of climate in that era. The 1883 Krakatoa explosion was the most memorable source of instability then: it appears to have diminished temperatures worldwide for up to three years.

Now consider the records from 1995 to 2014. If the climate were still relatively stable the expected number of hottest years on record would be about

$$\frac{1}{125} + \frac{1}{126} + \frac{1}{127} + \frac{1}{128} + \cdots + \frac{1}{144} \approx 0.15$$

In practice several 'hottest years on record' have been observed in recent times. And so this phenomenon by itself is evidence that the climate stability of 1871–1950 has changed dramatically.

This note was written after reading Julian Havil's book *Gamma* (Princeton Science Library, 2003).

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