The NEW Sunspot Numbers – But There's a Chink in the Armor

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My April 2016 Monthly Feature reviewed the efforts by solar scientists to "get the sunspot numbers correct" due to the advances in telescopes over the years (which affects the ability to see small individual sunspots – an important measurement in counting sunspots) and the bias of the 'official' observers over the years (it's unintentional, but it's there because we're human).

Four Sunspot Number Workshops were held beginning in 2011, and the result of those meetings were sunspot numbers that most of the group agreed upon as the true values. These new sunspot numbers have been reported by the Royal Observatory of Belgium beginning on July 1, 2015, and are designated V2 (the old sunspot numbers are designated V1).

Note that I said "most of the group". In my April 2016 article, I stated that "*The last Workshop reviewed the corrected time series of sunspot numbers from 1610 to the present, and reached an agreement to publish the new data.*" At the time I wrote the April article I didn't know if this agreement by the Workshop participants was unanimous or there were dissenters.

It's now apparent to me that there were dissenters based on a recent article in **Geomagnetism and Aeronomy** [note 1], hereafter referred to as **G&A**. The authors point to a pdf file by one of the Workshop participants who is from the Royal Observatory of Belgium [note 2].

The focus of the **G&A** article is on the relationship between the individual sunspot number and the associated group sunspot number. The Workshops attempted to minimize the discrepancy between the sunspot number and sunspot group series, and they concluded that during the period 1874 to 1976 (when the Royal Greenwich Observatory actively made sunspot observations) there were on average always the same amount of individual sunspots in a sunspot group – and that number is 12.08 to make the mean (average) Group Sunspot Number identical with the mean (average) Sunspot Number.

I thought it would be interesting to go through the sunspot number and group sunspot number data to confirm the Workshop's conclusion. Downloading and importing the new V2 sunspot number data into Excel was relatively easy. But downloading the new group sunspot number data was a problem – there is no agreement on which of the several available data sets is the truth. Looking at the group sunspot number data also came with a surprise. On each day, there were several observers, and they counted a different number of sunspot groups.

This was a revelation to me, as I believed counting sunspot groups was easy per the Workshop documents. Apparently my interpretation was off a bit!

Now back to the concern of the authors of the **G&A** article. They believe there is a loss of important information about the variability of the solar dynamo due to using mean (average) values of the sunspot number and group sunspot nuymber. This concern is based on data that shows a small cyclic variation over a century of recent data (comparable to the period looked at by the Workshops). Figure 1 shows this data, with Rz being the Wolf sunspot number per the equation $Rz = k(10g + n)$ and g being the number of sunspot groups [note 3].

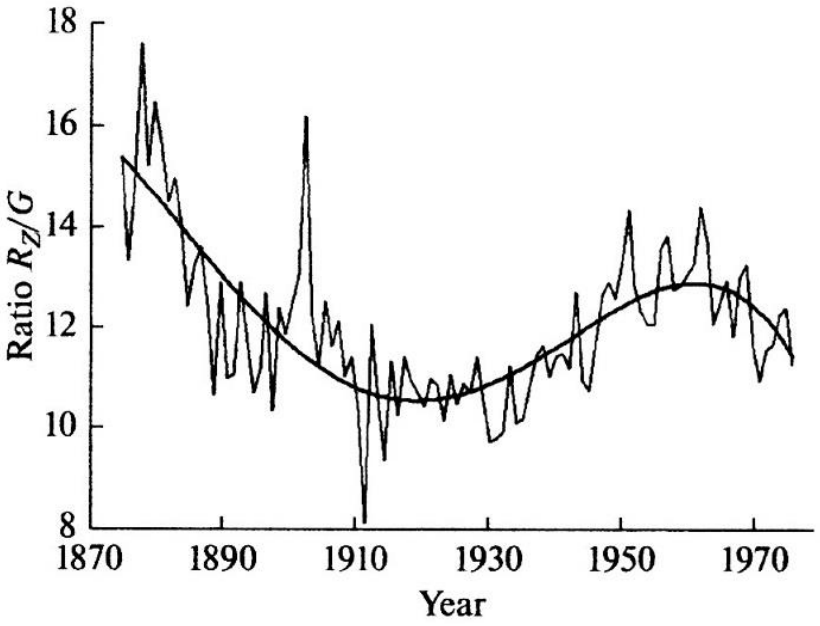

Figure 1 – Variation in the ratio Rz/G

The variability is only around +/- 10%, and as expected the "average" Rz/G ratio is around 12.08. But when you're trying to understand how the Sun works to make future predictions, this variability should be included.

Why is there variability? The authors of the **G&A** article point to previous work by one of their co-authors (Kilcik). Kilcik separated active regions into four types based on the size of the sunspot group and the sunspot evolution. These four types of active regions then give different Rz/G ratios. In other words, all active regions and the sunspots in them aren't the same.

So what does all this mean? I think it means there will be continued discussions of what the true sunspots numbers have been – and how we determine current numbers.

Notes:

1. K. Georgieva, A. Kilcik, Yu Nagovitsyn and B. Kirov; *The Ratio Between the Number of Sunspot and the Number of Sunspot Groups*; **Geomagnetism and Aeronomy**, Vol 57, No 7; pages 1-7; March 2017

   this article is available at https://arxiv.org/ftp/arxiv/papers/1710/1710.01775.pdf

2. http://www.spaceclimate.fi/SC6/presentations/session2b/Frederic_Clette_SC6.pdf

3. In the Rz equation, k is a correction factor for each observer, g is the number of sunspot groups and n is the number of individual sunspots