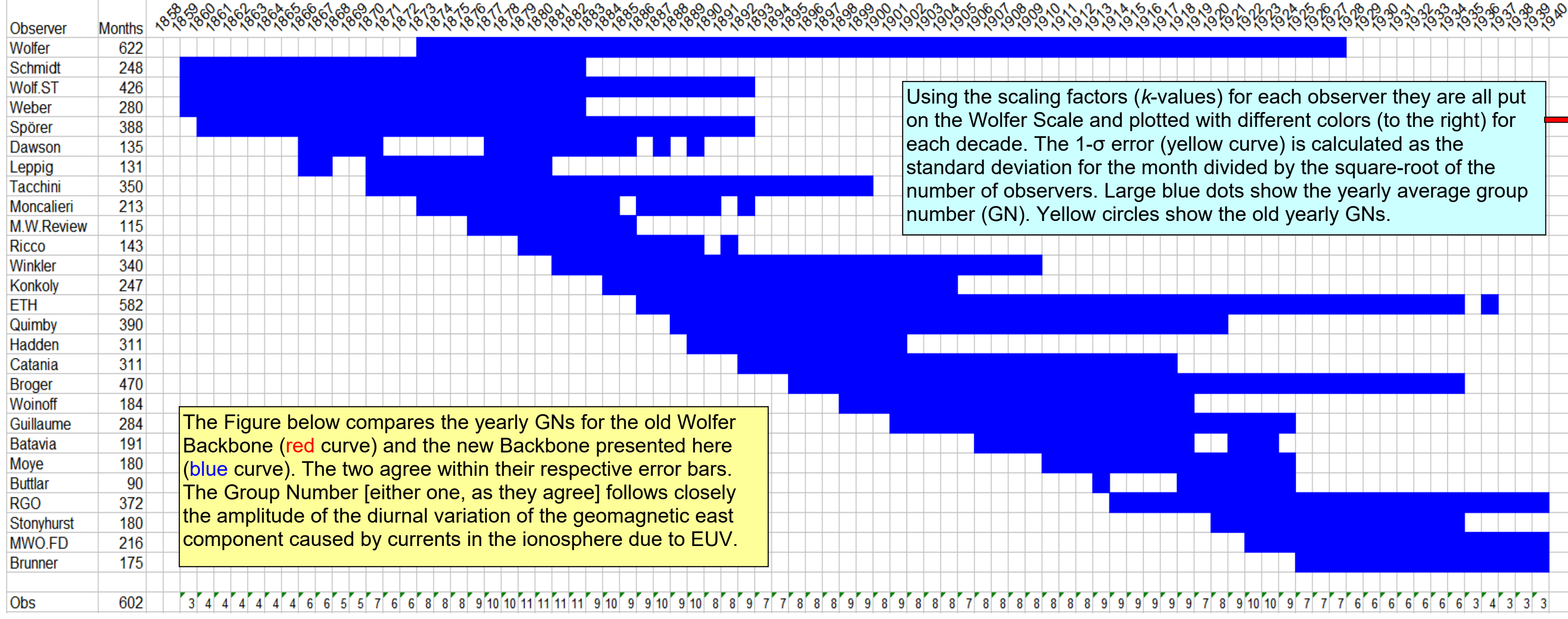


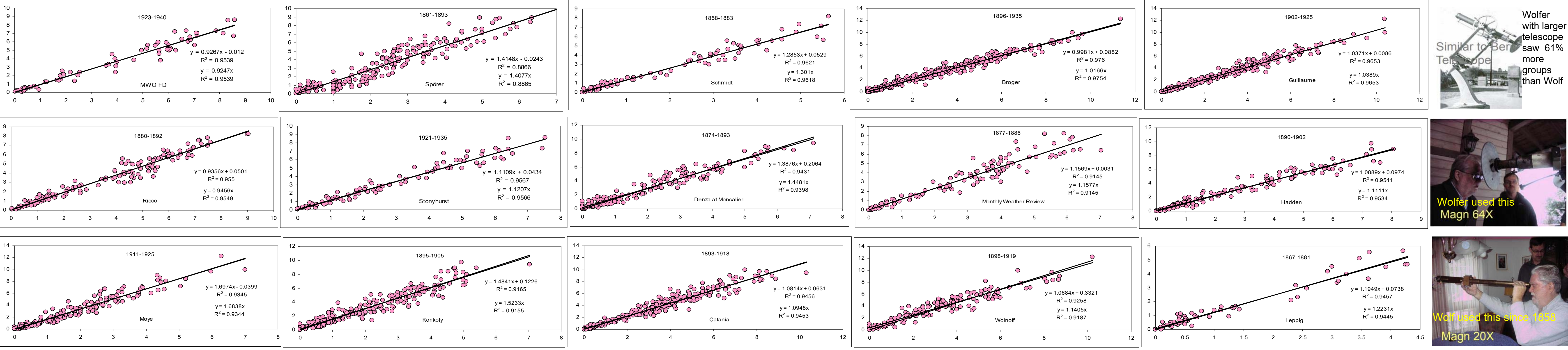
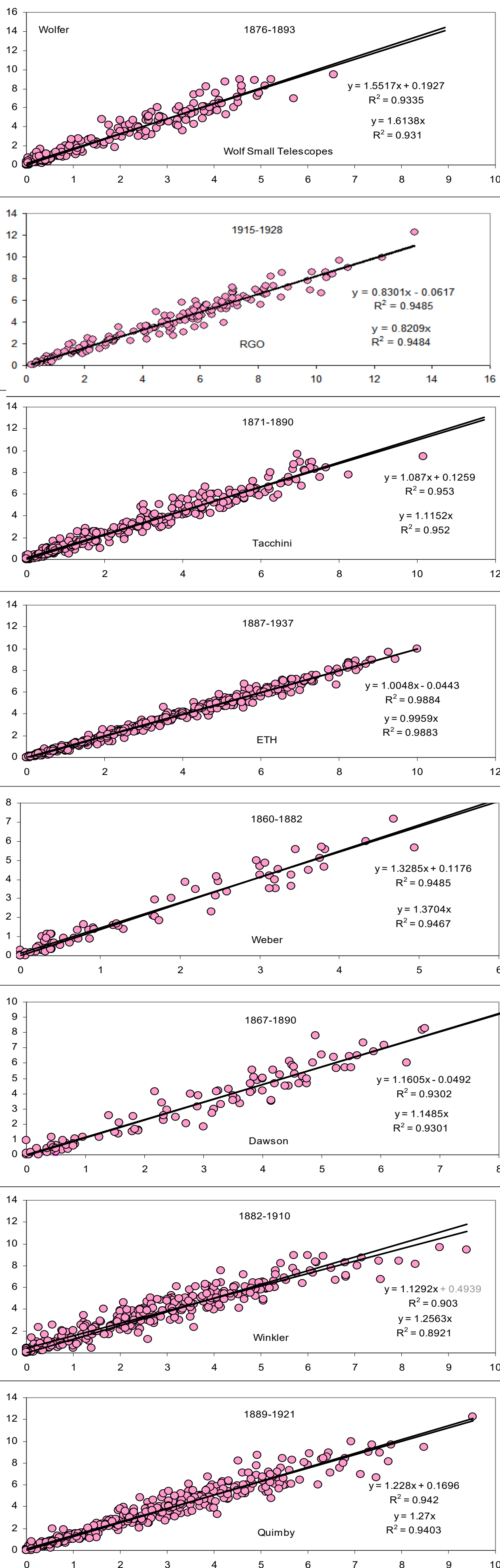
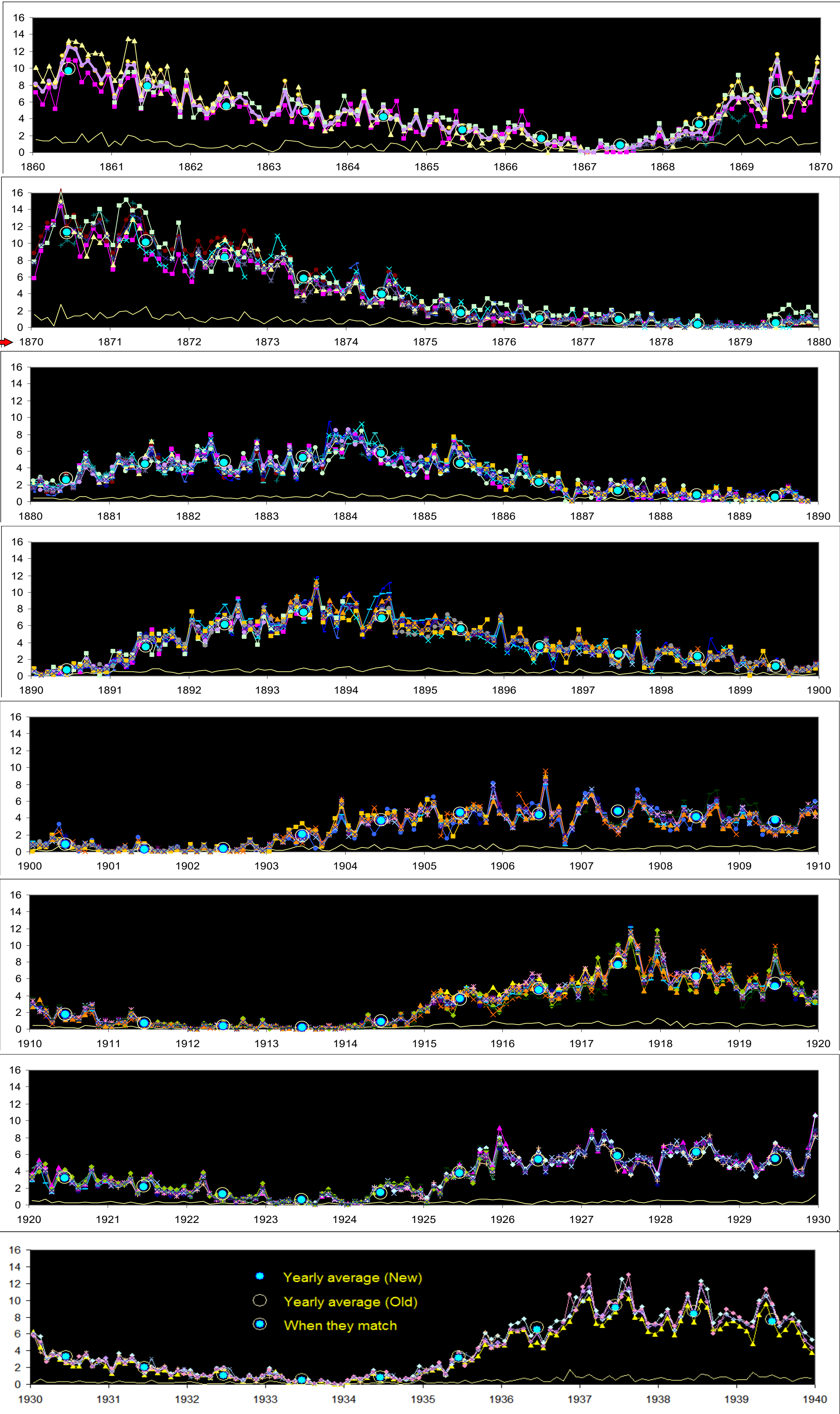
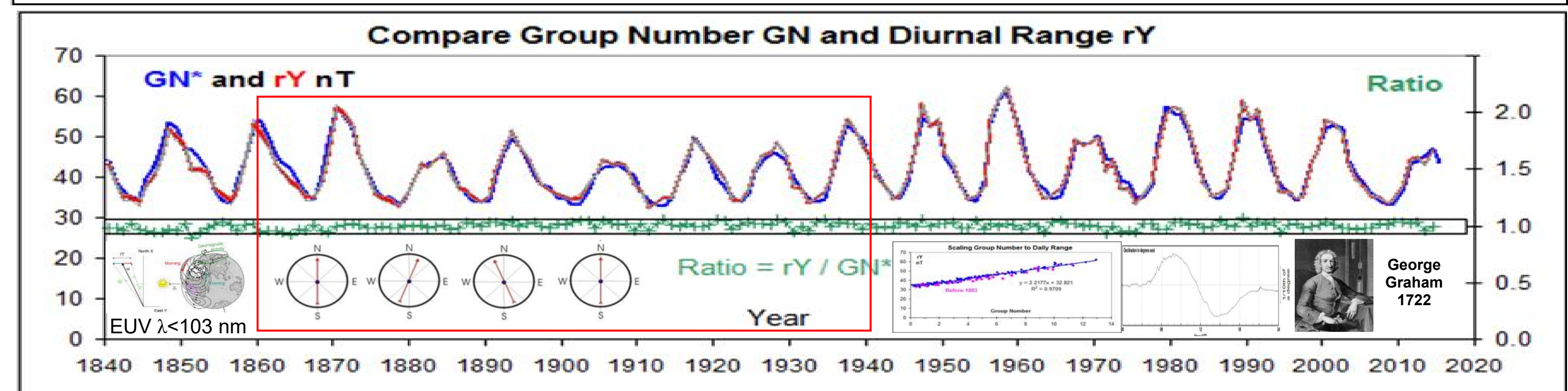
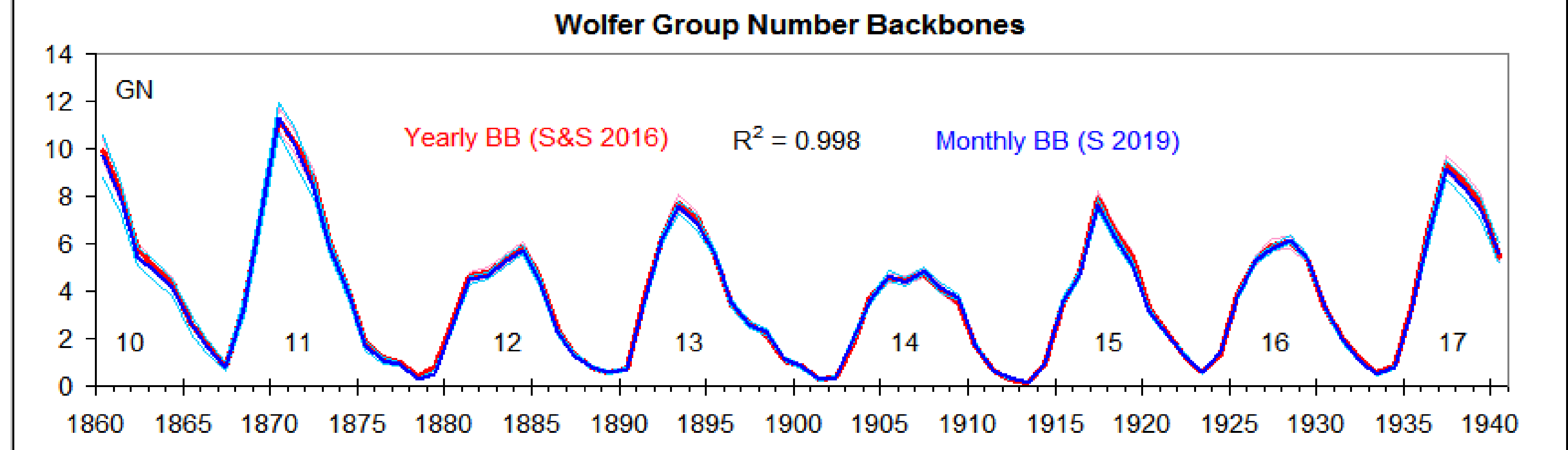
Re-analysis of the Wolfer Group Number Backbone

Leif Svalgaard, Stanford University

Svalgaard & Schatten (2016) used a 'backbone' method to reconstruct the Sunspot Group Number since 1610. Five backbones were used, centered and anchored on the Wolfer Backbone, which then defines the scale of the series. Backbones are constructed by scaling observers directly to the primary observer (e.g. Wolfer) without daisy-chaining through intermediary observers thus avoiding accumulation of errors. Each observer is scaled to Wolfer and we check that the relation is linear with insignificant offset (correlation plots at the left and below) defining a k -value. The data is taken from Svalgaard (2019) for the newly digitized Zürich drawings (ETH) and from Vaquero et al. (2016) for all other observers. To improve the time resolution (with better determination of error bars) the new Wolfer Backbone has monthly resolution rather than the previous one's yearly values. The Figure below shows the years for which good-quality observers have overlap with Wolfer (on average 22 years).



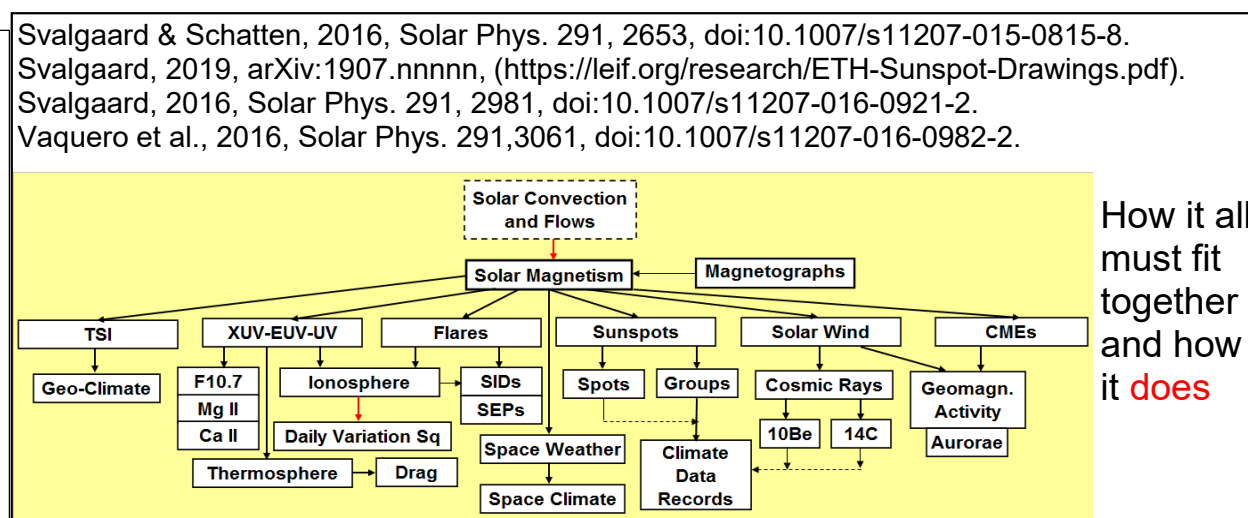
The Figure below compares the yearly GNs for the old Wolfer Backbone (red curve) and the new Backbone presented here (blue curve). The two agree within their respective error bars. The Group Number [either one, as they agree] follows closely the amplitude of the diurnal variation of the geomagnetic east component caused by currents in the ionosphere due to EUV.



Wolfer with larger telescope saw 61% more groups than Wolf

Wolfer used this Magn 64X

Wolf used this since 1658 Magn 20X



Conclusion
The Backbone Reconstruction of the Sunspot Group Number is anchored by the Wolfer Backbone. A new reconstruction with monthly time resolution covering the interval 1860-1940 using all long-term observers overlapping with Wolfer agrees well with a preliminary series (Svalgaard & Schatten, 2016) with yearly resolution. This resolves the problem of the correct level of activity in the latter part of the 19th century and paves the way for trustworthy reconstructions of TSI and the Open Magnetic Flux, and for calibration of the cosmic ray proxies.

No overlap with Wolfer for the low values during the 1932-1933 minimum

How it all fits together and how it does