

# Sunspot observations by D. E. Hadden during 1890-1931

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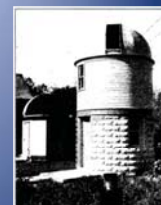
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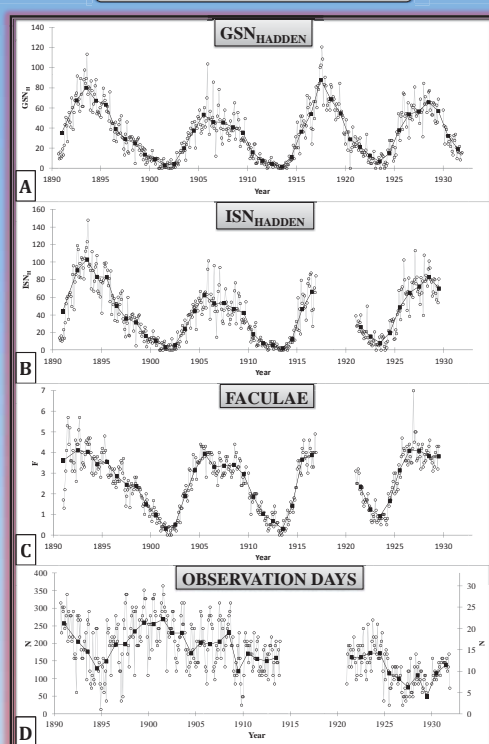
## ABSTRACT

We have recovered the sunspot observations made by David E. Hadden during 1890-1931 from Alta, Iowa. We have digitized the available data published by Hadden in different astronomical journals. This data series have been analyzed and compared with the standard sunspot number series. Moreover, we provide additional information on two great sunspot groups, previously not described, that originated two important extreme episodes of space weather on February 1892 and September 1898.

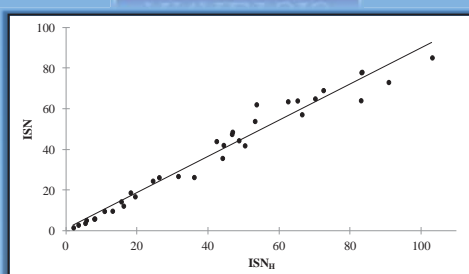
## DAVID E. HADDEN



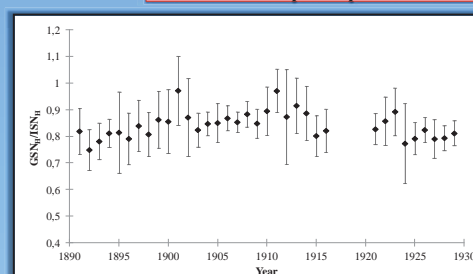
## AVAILABLE DATA



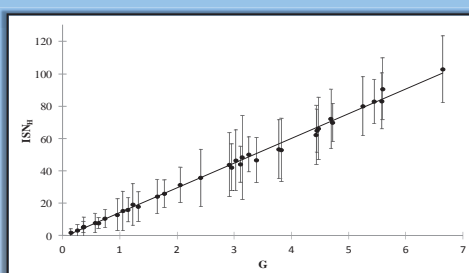
## ANALYSIS



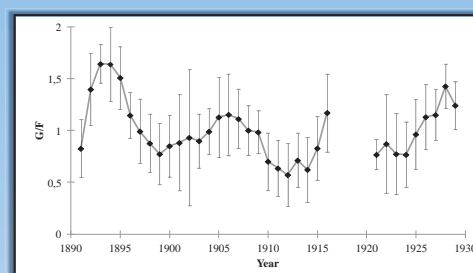
ISN vs. ISN<sub>HADDEN</sub>  
 $k_{HADDEN} = 0.91 \pm 0.02$



ISN → International Sunspot Number  
GSN → Group Sunspot Number



ISN<sub>HADDEN</sub> vs. Groups  
slope =  $15.0 \pm 0.1$

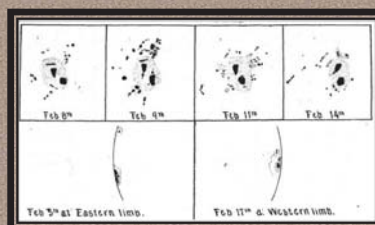


GSN<sub>HADDEN</sub>/ISN<sub>HADDEN</sub> vs. Year  
(one standard deviation)

## GREAT SUNSPOTS

February 1892

September 1898



"[...] the entire region just preceding, and for some distance following, and also north and south of the spot, was greatly agitated; the Ha line being reversed and distorted; small black jets projecting from either side of the line were noted in several places, and on opening the slit slightly, the flame and spike-like form of the disturbances could be clearly seen. At 12 m. intensely brilliant flames were observed over the large spot extending from the umbra to the edge of the penumbra on the east side. This phenomenon was particularly striking; the intensely bright scarlet flame nearly in the center of the dark absorption band of the spot spectrum, being very interesting. The D<sub>3</sub> line was bright; while D<sub>1</sub> and D<sub>2</sub> and many other lines were widened. At 12h. 5m. p.m. a small dark line attached to the Ha line extended obliquely towards the red end of the spectrum, in the region just preceding the main spot. Observations were interrupted at 12h. 10m., and could not be resumed until 1h. 40m., but the entire disturbance had then almost ceased, only a few slight reversals being noted. A 2-inch diffraction grating, attached to a 4-inch telescope, was used" [Hadden, David E., 1899. Great sunspot September 1898. Publications of the Astronomical Society of the Toronto 1898, 89-90]

ISN<sub>HADDEN</sub>/ISN(squares) & GSN<sub>HADDEN</sub>/GSN(circles) vs. Year  
(color bars indicate the telescopes used by Hadden)

## CONCLUSIONS

- We have made a compilation of data about solar observations made by David E. Hadden during the period of 1890 – 1931 (spots, groups and faculae).
- The majority of these observations were not compiled by Hoyt & Schatten.
- We have recovered daily data for the period 1890-1902. Monthly data are available for the remaining period.
- In general, the ISN<sub>HADDEN</sub> and GSN<sub>HADDEN</sub> indices are comparable to standard values of ISN and GSN.
- The calibration constant for Hadden as observer was obtained. The ISN<sub>HADDEN</sub>/Group ratio was computed (no significant changes).
- Finally, we have recovered some detailed information of two large sunspot groups that caused two of the major magnetic storms recorded.

## ACKNOWLEDGEMENTS

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## More information

<http://arxiv.org/abs/1305.6661>