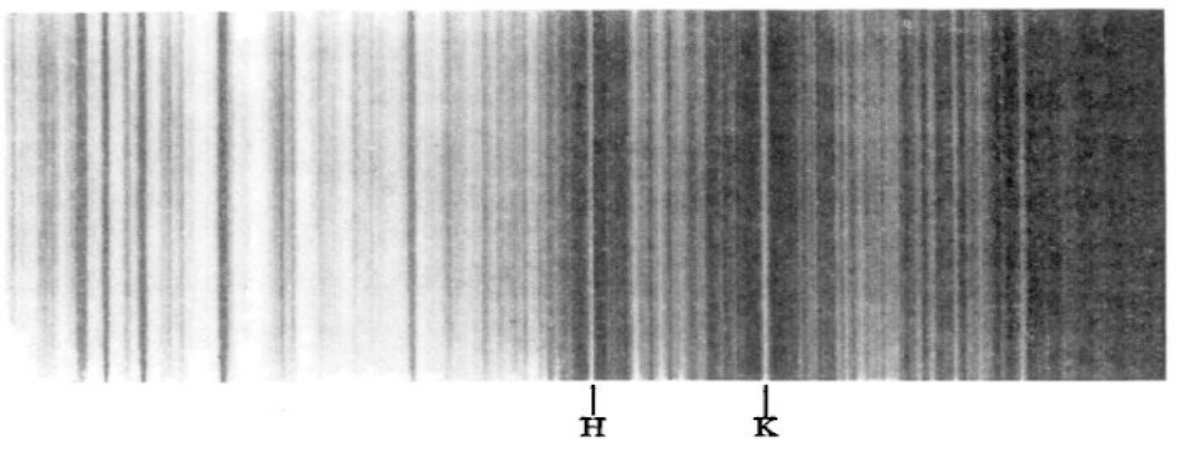
The Variability of Sun-like Stars

Jeffrey C. Hall, Lowell Observatory

March 22, 2018
2018 SORCE Sun-Climate Symposium
Lake Arrowhead, CA

1 - Context

Where it all began, 1913



"…It remains to be shown whether the emission lines of the star have a possible variation in intensity analogous to the sun-spot period."

- Eberhard & Schwarzschild, 1913, ApJ, 38, 292, in "Minor Contributions and Notes"

1 - Context

The Mount Wilson Observatory (MWO) HK Project, 1966-2003

I. INTRODUCTION

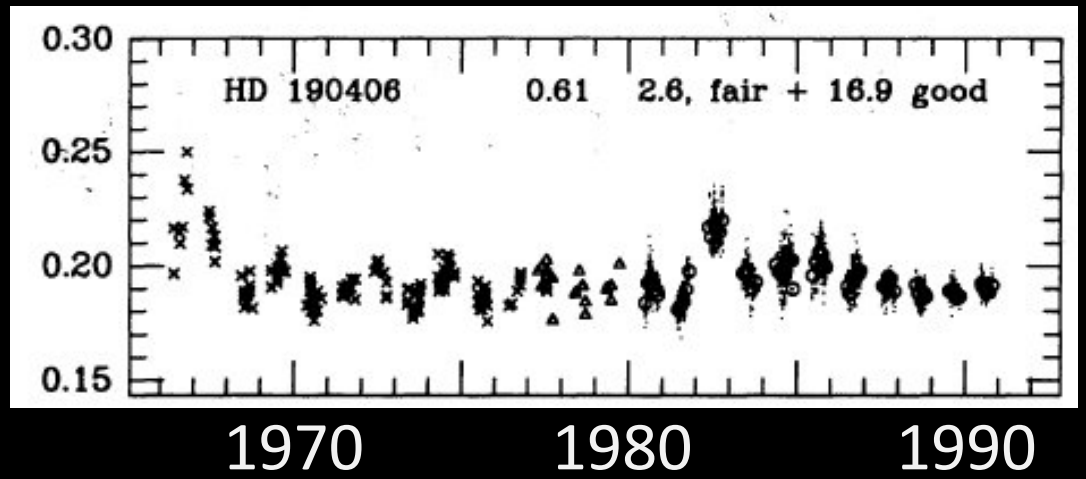
This work was undertaken to answer the general question, Does the chromospheric activity of main-sequence stars vary with time, and if so, how? The most accessible indices of chromospheric activity in these stars are the emission components centered in the broad, deep H and K absorption lines of Ca II.

- Wilson 1978, ApJ, 226, 379, "Chromospheric Variations in Main Sequence Stars"

1 - Context

The Mount Wilson Observatory (MWO) HK Project, 1966-2003

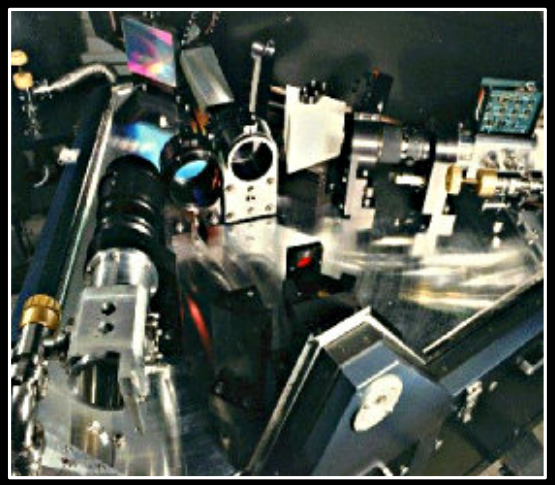
S



- Baliunas et al, 1995, ApJ, 438, 269, "Chromospheric Variations in Main Sequence Stars. II"

1 - Context

The Solar-Stellar Spectrograph (SSS) HK Project, 1992-2018+



1 - Context

The Lowell-Fairborn Photometry Program, 1984-2018+

1 - Context

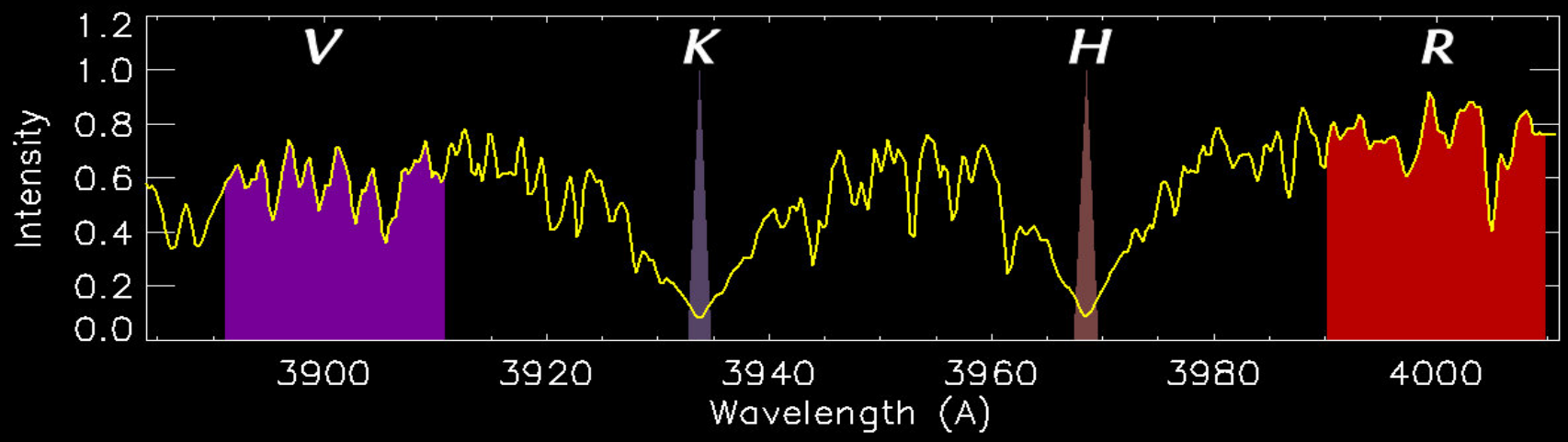
The SSS Team Today

HALL
LOCKWOOD,
SKIFF
BRIGHT
BAYER

EGELAND
METCALFE

HENRY
BOYD
RADICK
PEVTSOV

2 – MWO and SSS Data: The Good, the Bad, and the Ugly



$$S = \alpha \frac{H+K}{R+V}$$

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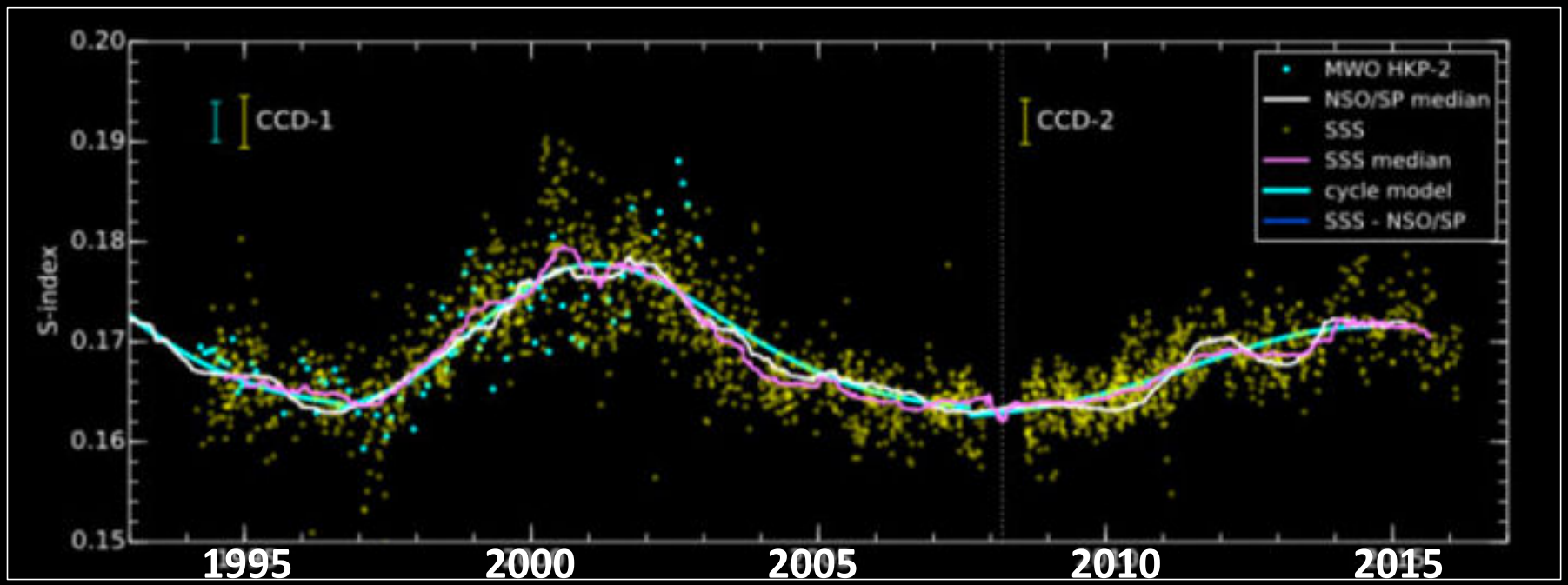

- Egeland, R., et al. 2017, ApJ, 835, 25, The Mount Wilson Observatory S-Index of the Sun

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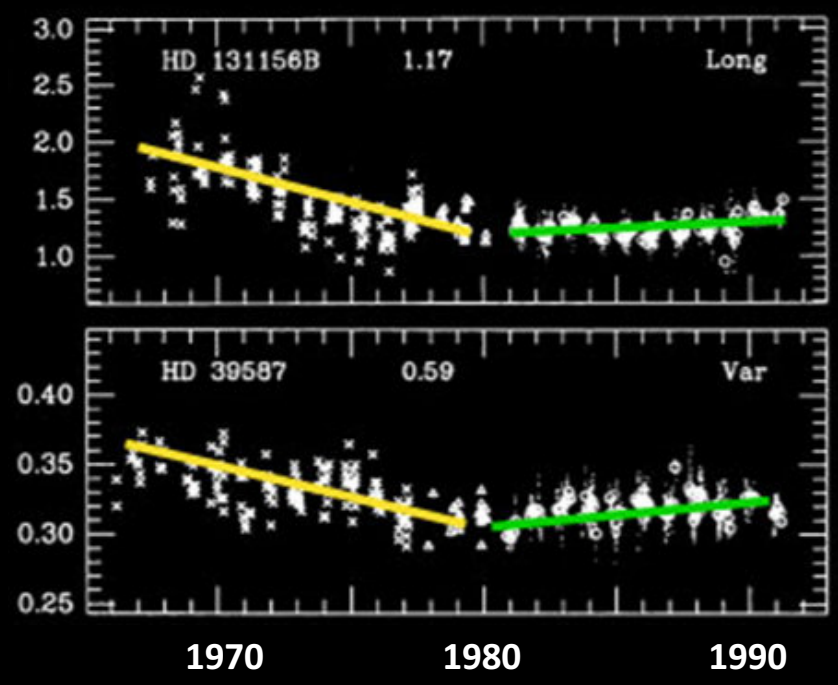

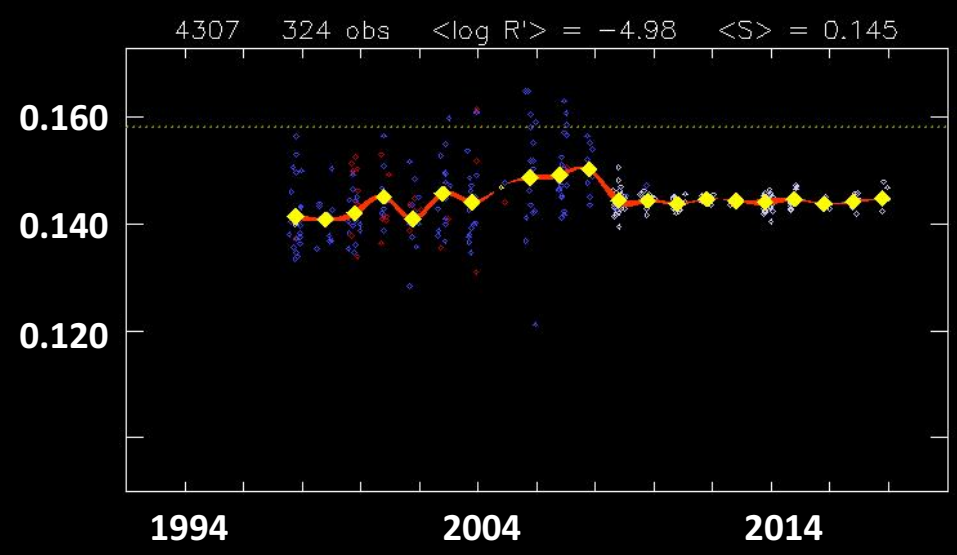

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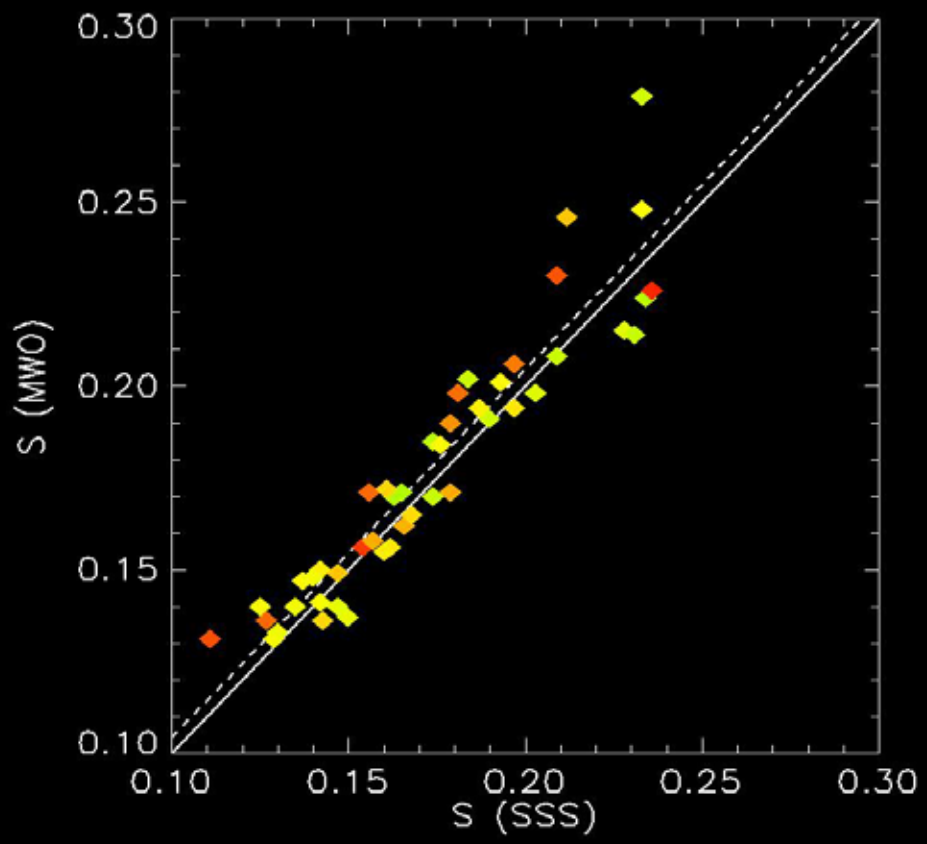
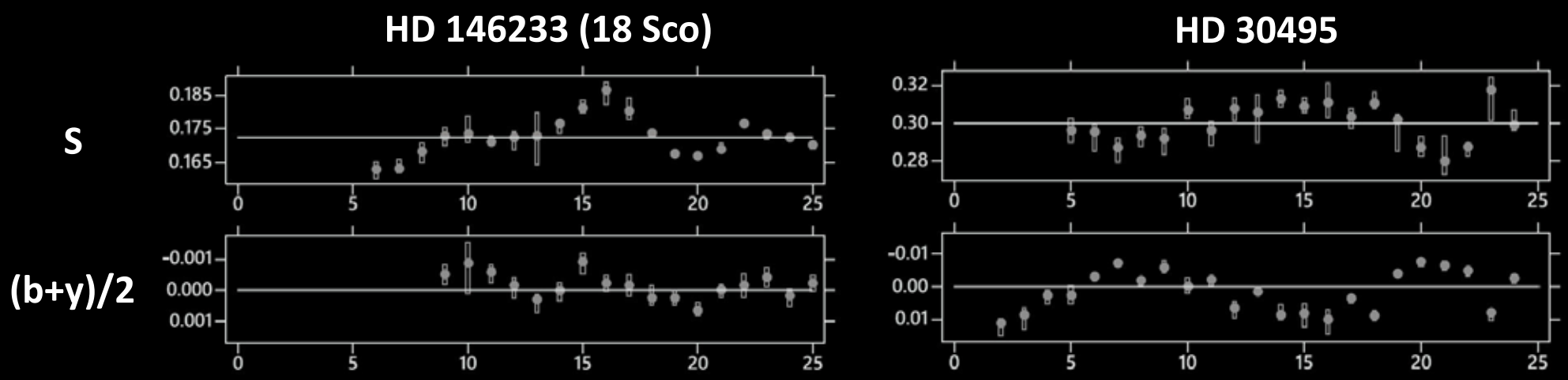


3 – Recent Progress and Conclusions

3A – Patterns of Stellar Variations
3B – Activity Cycles in the SSS Data
3C – The Nature of Flat Activity States in Solar Analog Stars
3D – Searching for Stellar Maunder Minima

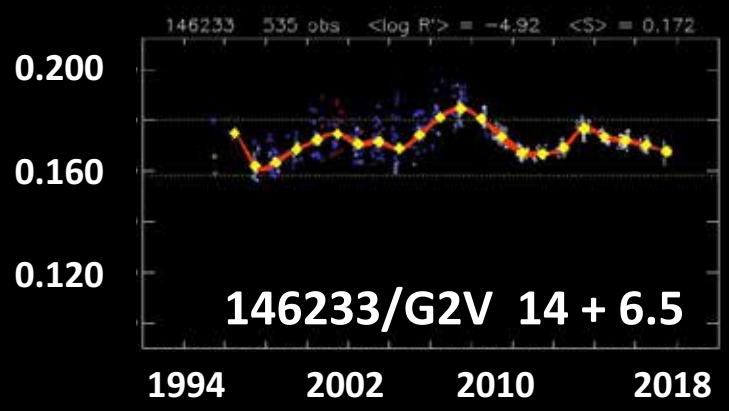
3A – Patterns of Stellar Variations

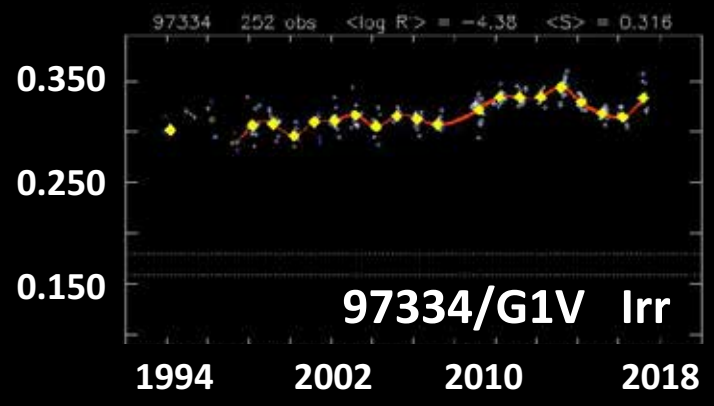
Patterns of Variation for the Sun and Sunlike Stars

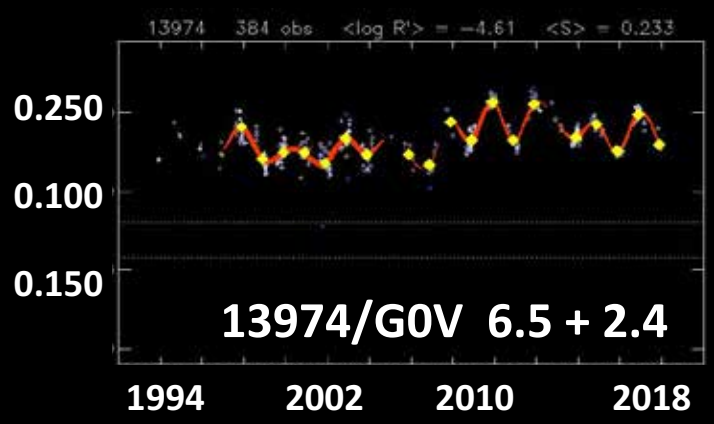


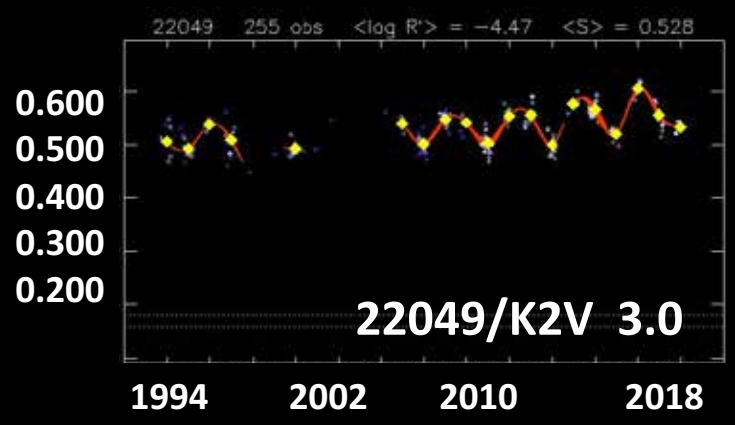
- Radick, Lockwood, Henry, Hall, & Pevtsov 2018 ApJ 855 75

3B – Activity Cycles in the SSS Data









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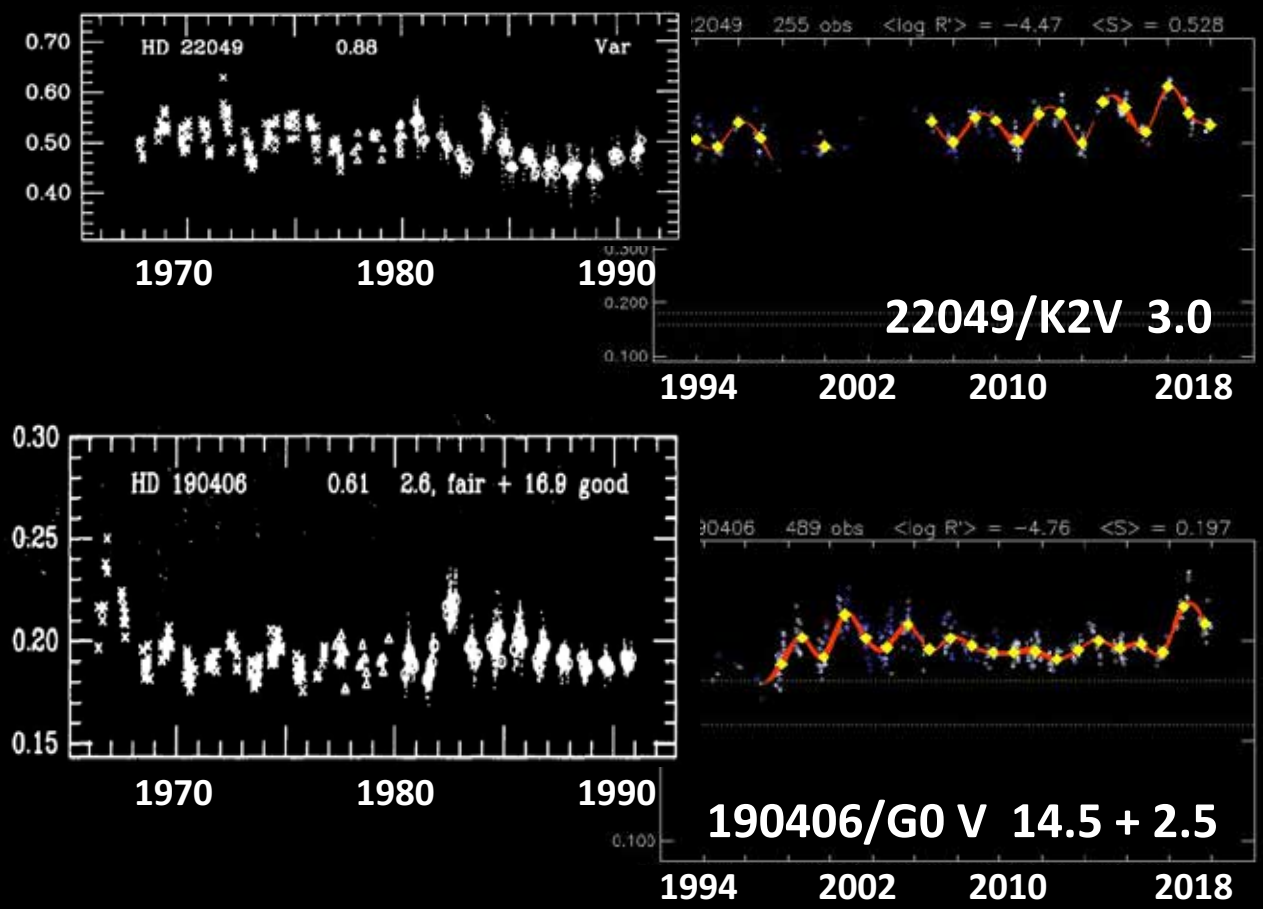
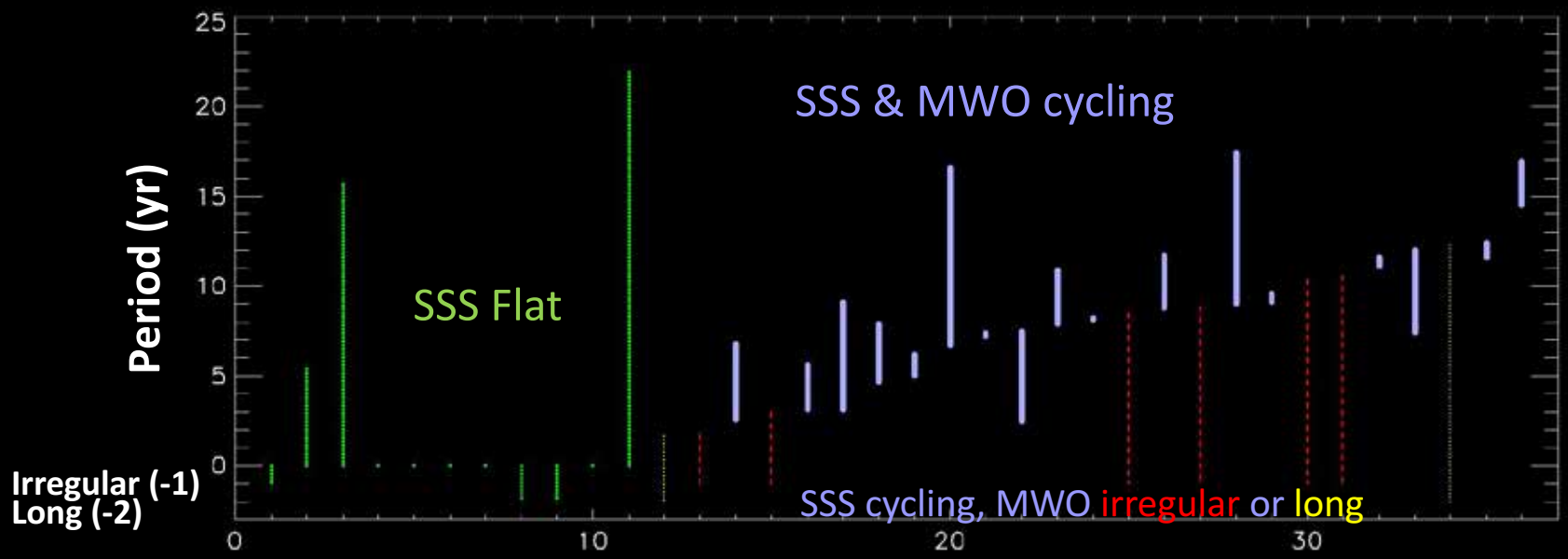


3B – Activity Cycles in the SSS Data

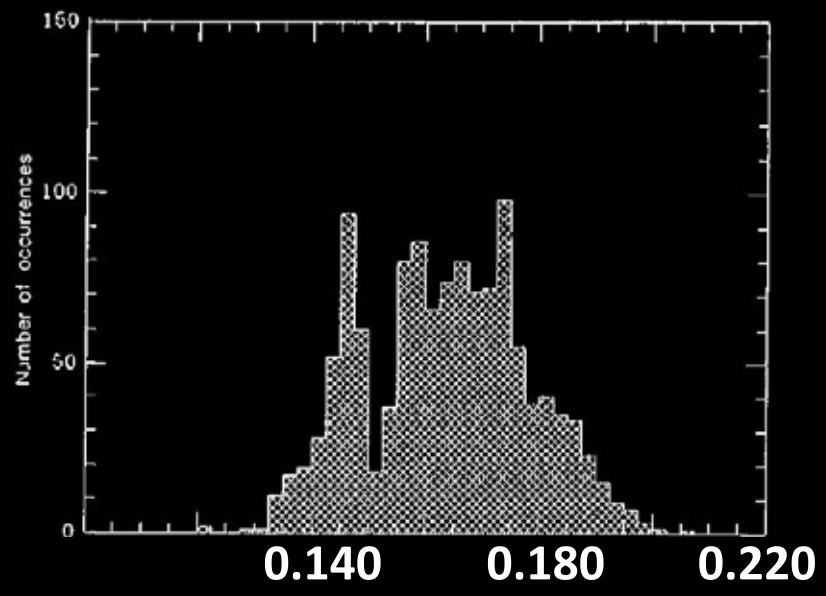
92 densely sampled stars

35 cycling, 6 irregular, 30 flat, 7 long, 2 hybrid…and 12 to go!

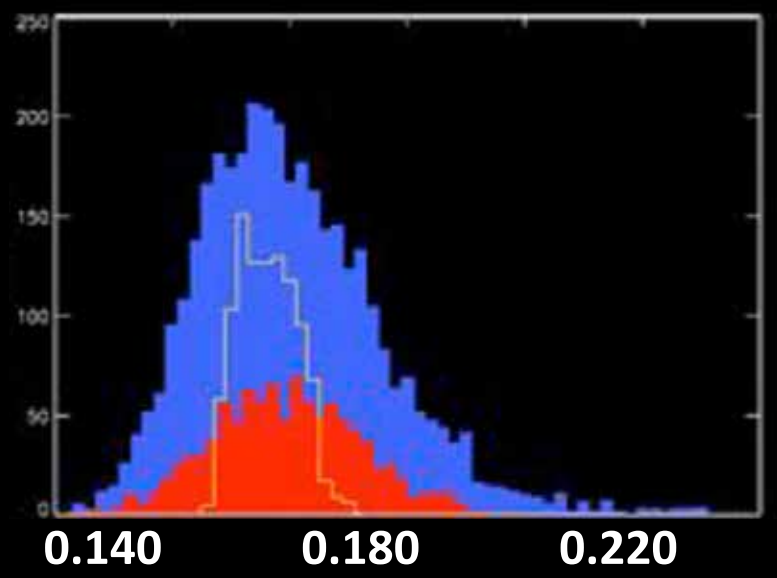


36 stars that overlap long-term MWO targets

3C – The Nature of Flat Activity States in Solar Analog Stars

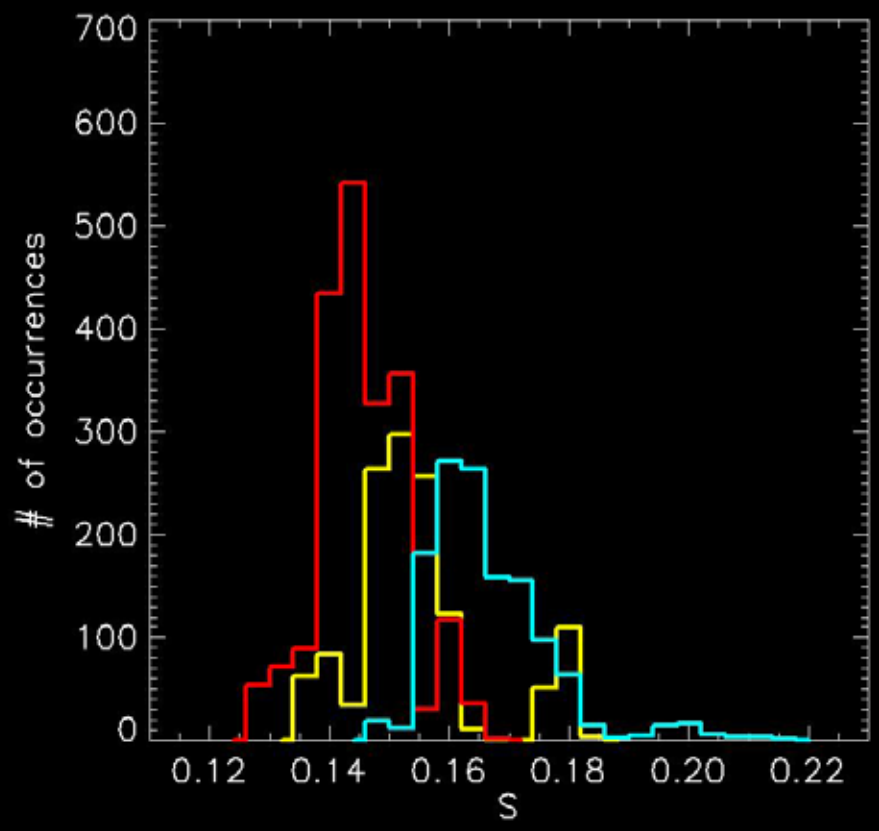


Baliunas & Jastrow 1990

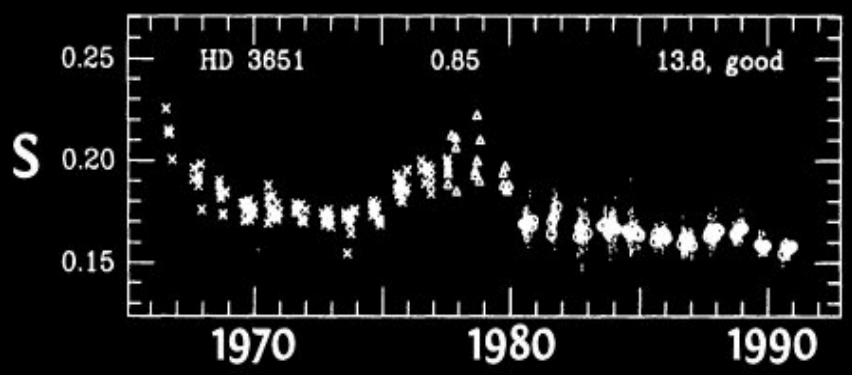


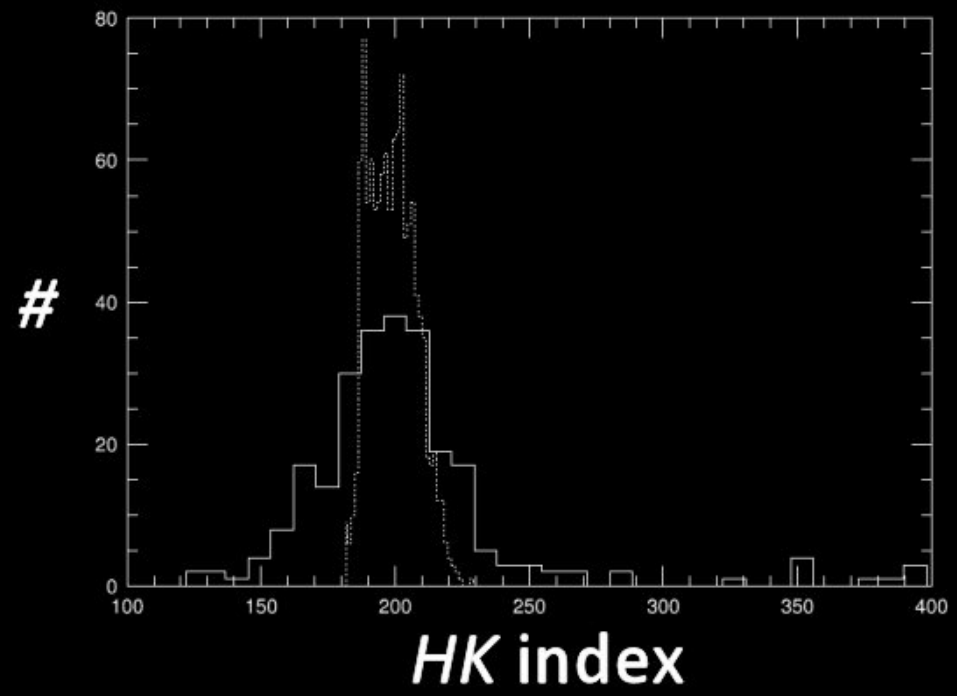
Hall & Lockwood 2004

3C – The Nature of Flat Activity States in Solar Analog Stars



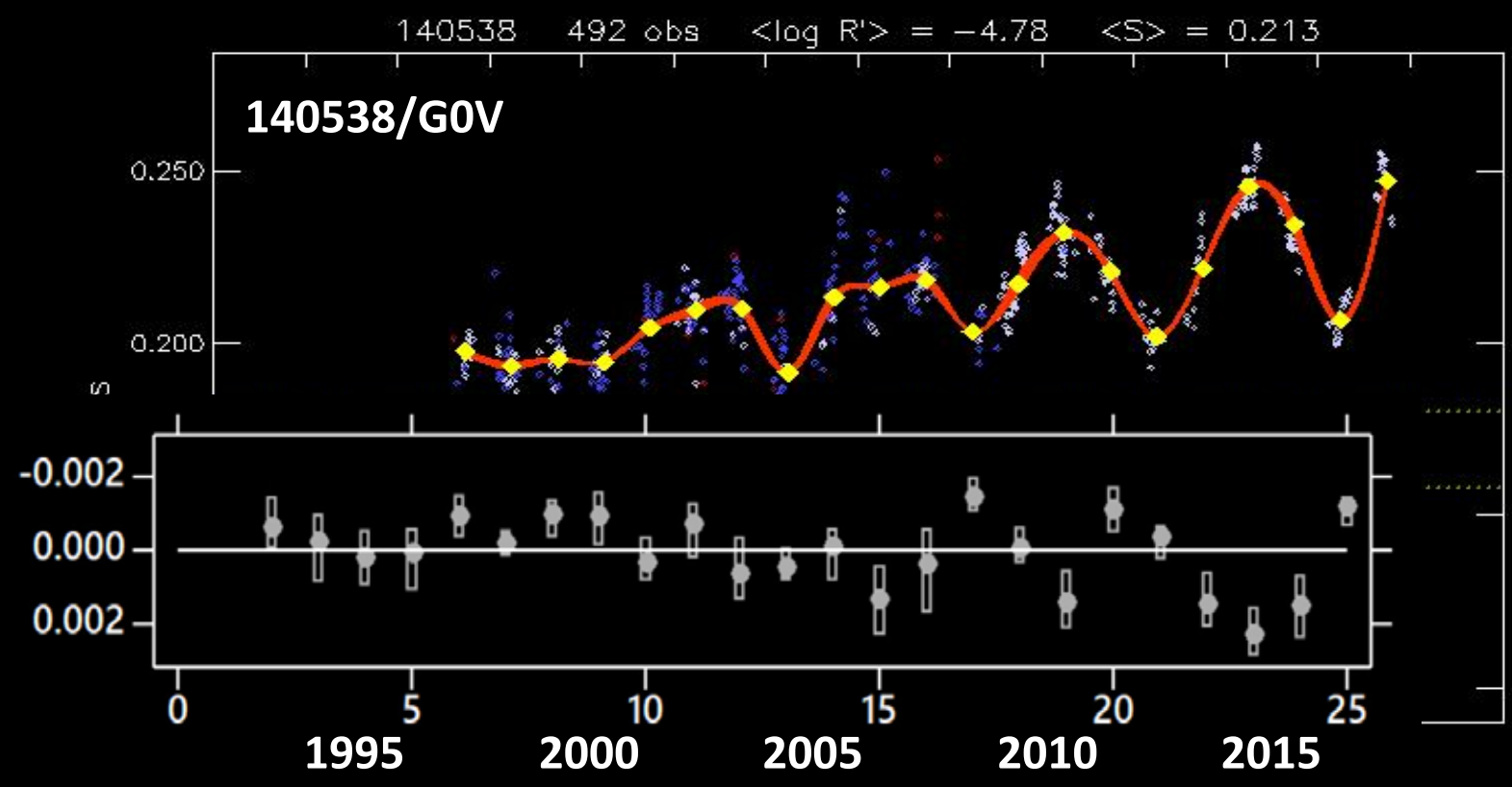
3D – Searching for Stellar Maunder Minima





Giampapa et al. 2006

3D – Searching for Stellar Maunder Minima



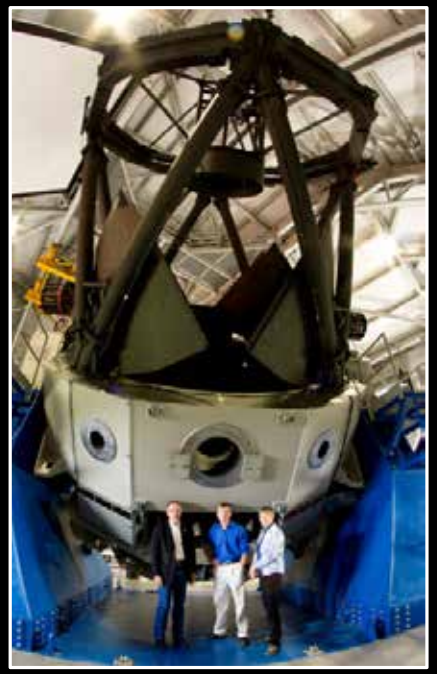
4 – After 52 Years, Now What?

1. An SSS + MWO Database for the Community

2. Observations of ~35 solar analogs + a “snapshot” survey

3. Design and development of follow-on program

4 – After 52 Years, Now What?



Thank you, SORCE!