A NEW GENERATION OF LONG-TERM VARIABILITY DATASETS WITH BETTER ESTIMATES OF UNCERTAINTY

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TAKE HOME MESSAGE

• There is a lot more uncertainty regarding solar long-term variability than most people realize.

• Current sunspot group data composites have no estimation of uncertainty.

• If you are using sunspot group data it is better to be careful with small objects.

• If you want a sunspot group data composite, RGO/SOON is not a very good choice.

• We are constructing a new, better sets of composite data for long-term variability studies.
THE BIGGEST DIFFICULTY OF STUDYING LONG-TERM SOLAR VARIABILITY:

ALL SURVEYS COME TO AN END AND WE NEED TO PIECE THEM TOGETHER.
THE BIGGEST DIFFICULTY OF STUDYING LONG-TERM SOLAR VARIABILITY

PIECING TOGETHER MULTIPLE SURVEYS IS NOT A TRIVIAL EXERCISE
TAKE THE BLUE PILL
THE STORY ENDS
I WAKE UP IN MY BED
AND BELIEVE DATA COMPOSITES
ARE PERFECT.

TAKE THE RED PILL
STAY IN DATA WONDERLAND
I FIND OUT
HOW DEEP
THE RABBIT-HOLE GOES.
DOWN THE RABBIT-HOLE
THE LONGEST RECORDS

<table>
<thead>
<tr>
<th>Data Product</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunspot Number Counts</td>
<td>400 Years</td>
</tr>
<tr>
<td>Sunspot Drawings and plates</td>
<td>200 Years</td>
</tr>
<tr>
<td>Calcium images</td>
<td>100 Years</td>
</tr>
<tr>
<td>Full-disk Magnetograms</td>
<td>40-50 Years</td>
</tr>
</tbody>
</table>

I’m currently involved in the creation of better data products for 3 of them and will focus today on the first two.
SUNSPOT NUMBERS: A LONG-TERM SOLAR OBSERVATIONAL NETWORK
THE HOYT AND SCHATTEN SERIES

- The golden standard for studying long-term solar variability for nearly two decades.
- It suffers from a host of issues that have not been yet fully reconciled.
The proposed solution to these issues (the backbone method) results on a series with little evidence of a long-term trend in solar activity.
HOWEVER, TWO IMPORTANT GROUPS IN EUROPE DISPUTE THESE RESULTS

And propose methods that recover the long-term trend in solar activity.
WHY IS THIS TASK SO DIFFICULT?

- Each circle in this network represents an observer.
- Each pair of observers that have at least 10 days of observation in common are linked with a line.
- The visualization of this network highlights two main problems.
1. There is an observational disconnection around 1740.
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2. Threading different paths through the network yields different composites.
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2. Threading different paths through the network yields different composites.
WHAT IS BEING DONE TO ADDRESS THESE ISSUES?

- We are using the relationship between the amount of active days and solar activity to get a handle on maunder minimum conditions.

- We are applying pathfinding algorithms to the network of observers to find the optimal paths and estimate uncertainty.

- We are submitting an ISSI proposal to work together fixing these issues, but in the meantime please keep in mind that solar variability is much more uncertain than most people realize.
A BETTER COMPOSITE OF SUNSPOT GROUP OBSERVATIONS
THE RGO/SOON COMPOSITE

- Combines sunspot group measurements taken by the Royal Greenwich Observatory (RGO; 1874-1976) and the Solar Observing Optical Network (SOON; 1976 to present).
- This composite has been of incredible value for studying Total Solar Irradiance.
- Since its inception there has been controversy as to how to calibrate RGO and SOON (with proposed factors between 1 and 1.7).
RGO and SOON have different thresholds of detection. This surely has impact on the calibration factor the community cannot agree upon.
THERE ARE SURVEYS THAT ARE MORE COMPATIBLE WITH RGO THAN SOON

Other surveys have a better match with RGO on the distribution of detected object sizes than SOON.
A BETTER AND LONGER COMPOSITE

It is better to be very careful with data near your threshold of detection
Uncertainty in area measurements takes place on the perimeter of the objects.
WITH BETTER ESTIMATES OF UNCERTAINTY

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WE ARE BUILDING A COMPOSITE FOR YOUR MAXIMUM LONG-TERM ENJOYMENT
KEEP THE WHEELS TURNING!

REPAIR WORK is VITAL to the WAR EFFORT

ISSUED BY THE MINISTRY OF WAR TRANSPORT

MAKING KPVT FULL DISK MAGNETOGRAMS GREAT AGAIN
Some things you can’t put into words—

THE DUMONT LUXURY MODELS
The Westminster..... 82405
The Hampshire..... 82407

DUMONT
First with the Finest in Television
Polarity Orientation, Flux, and Tilt
COOK the Modern Way ELECTRICALLY...safe...clean...economical
KPVT Data are underutilized because it has some outstanding problems
ZERO POINT ERRORS
ZERO POINT ERRORS

Fixed
GEOMETRY

Fixed
GAIN

1980-07-28 (PREVIOUS Img.)

1980-07-30 (CURRENT Corrected)
Correction Factor: 2.15

1980-07-31 (NEXT Img.)

Fixed
CURRENT STATUS

- Most of KPVT-512 and 40% of KPVT-SPMG have been fixed. ~7000 Magnetograms from 1976-1999.
- The goal is to replace old, biased diachronic synoptic maps and add daily synchronic synoptic maps for the KPVT era.
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WHERE DO I GET THESE AWESOME DATA?

Databases can be accessed at:

dataverse.harvard.edu/dataverse/solardynamo

Updates and new databases will be announced at:

facebook.com/solardynamo
twitter.com/solardynamo

www.solardynamo.org