When a Decade is Not Enough: Long-Term Synoptic Data Records, Their Continuity and Preservation

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National Solar Observatory

NSO INTEGRATED SYNOPTIC PROGRAM

NISP

NSO

Why “synoptic” if we have new high-resolution data?

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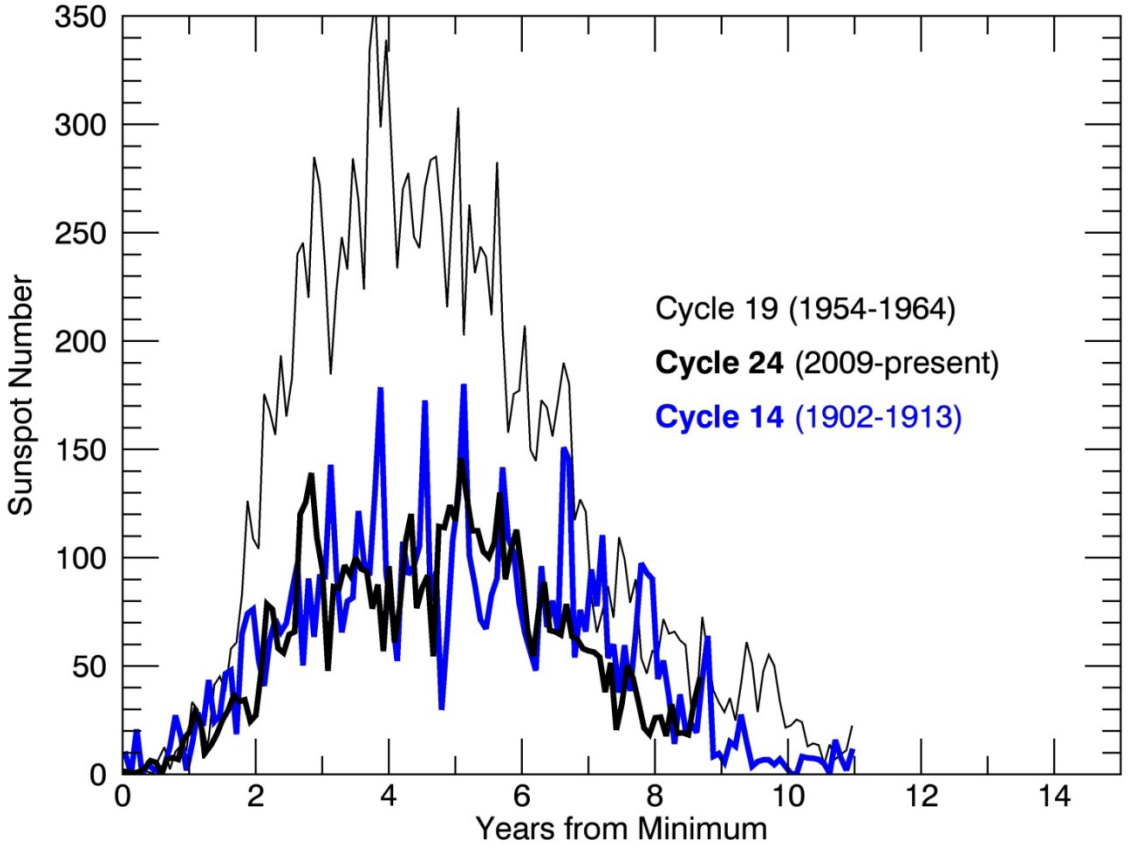
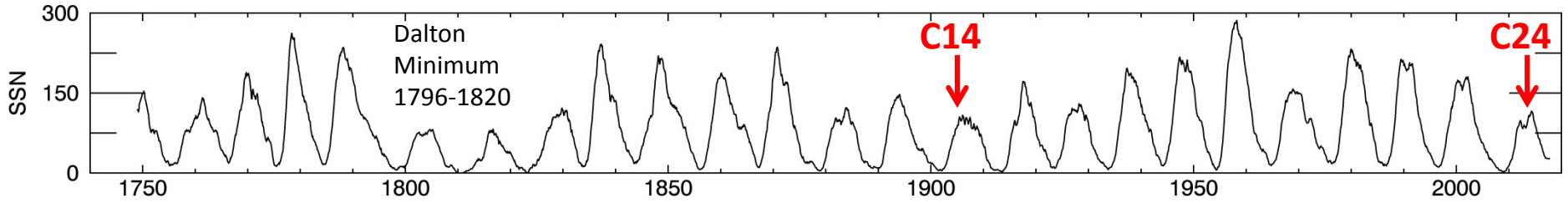
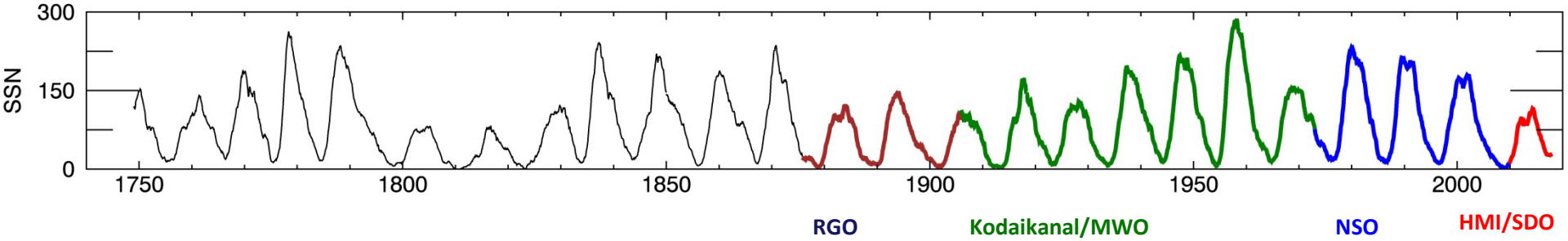


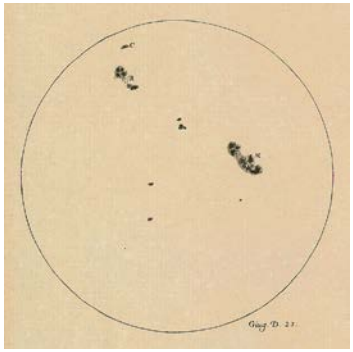


Why long-term/synoptic programs?

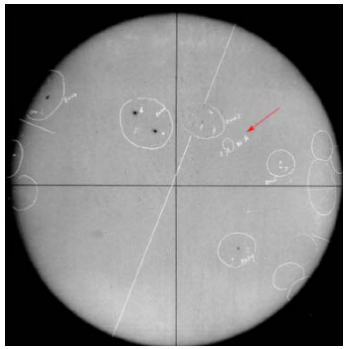
- Benchmarking: provide reference for “typical/ normal” state of natural systems (sun)
- Systemic change: Provide information about evolutionary changes in natural systems
- Exploratory: synoptic observations of solar activity feed future research to solve issues that may not be identified at the time when data are acquired

How useful “old” data are?

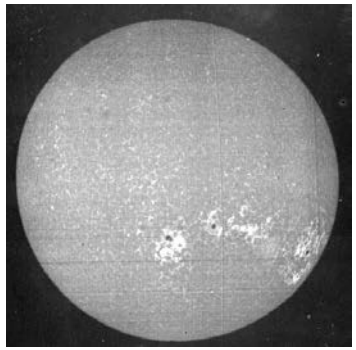


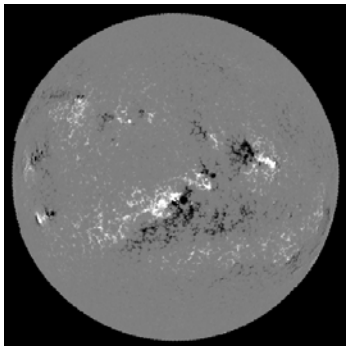


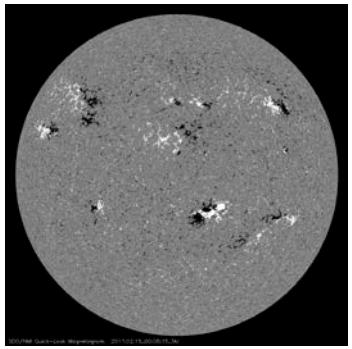
Galileo, 1613



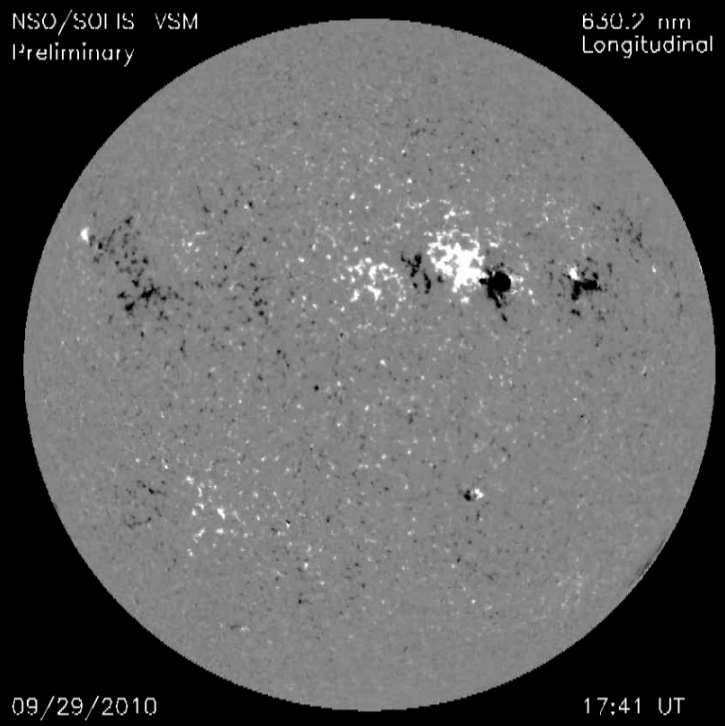
Willis et al (2016)

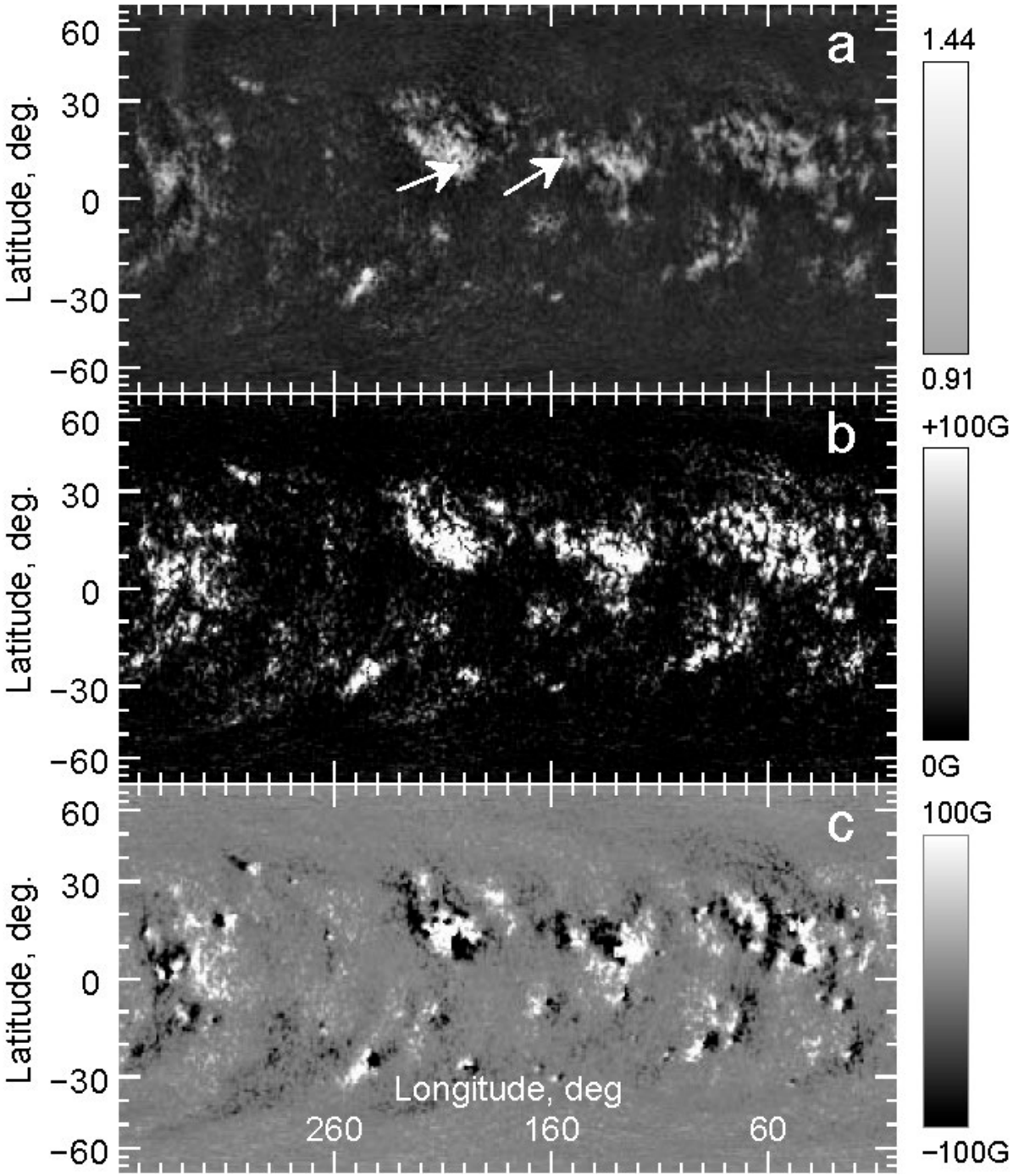






Synoptic/Carrington maps





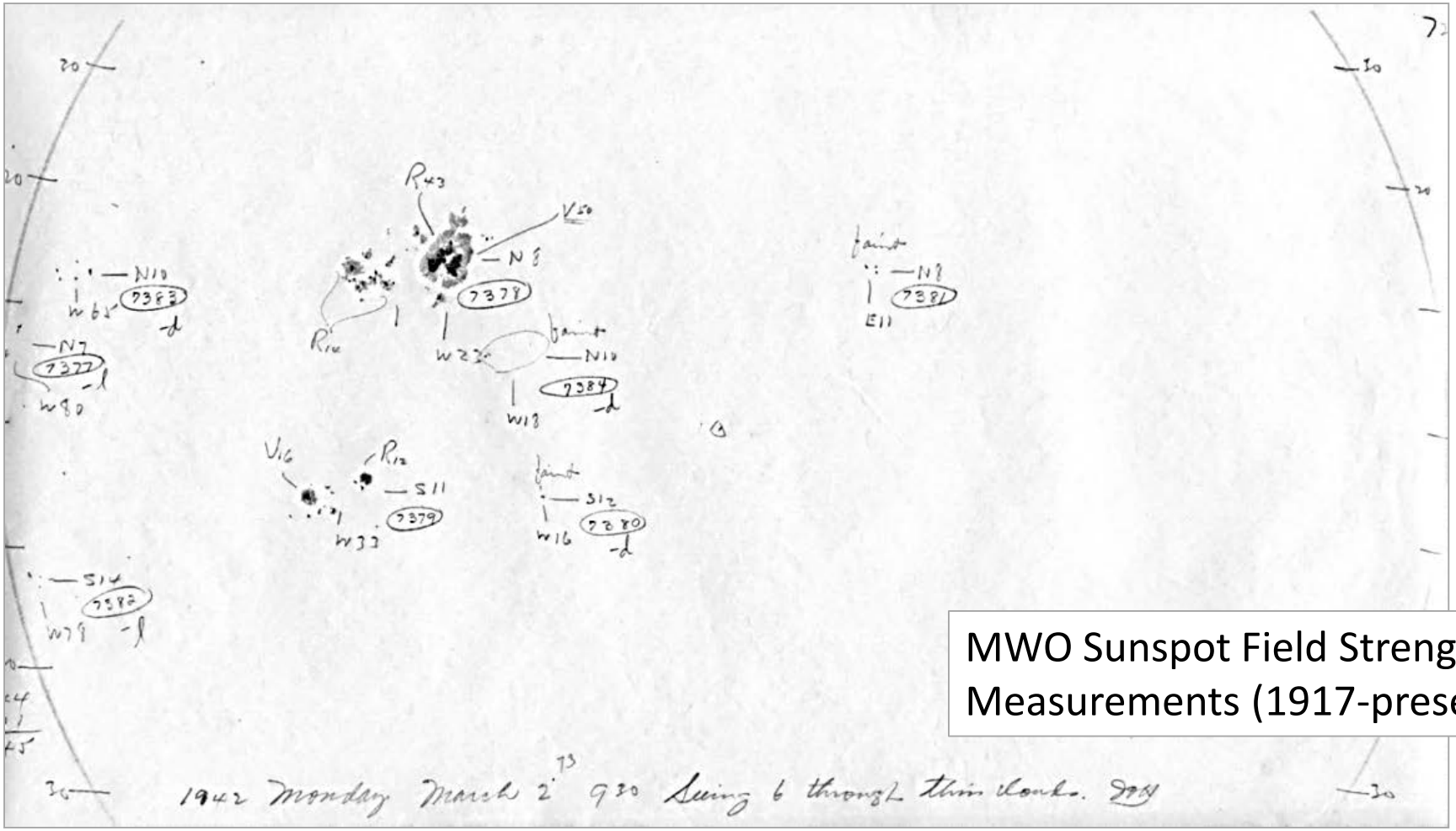
Ca II K synoptic map

Unsigned magnetogram

Signed magnetogram

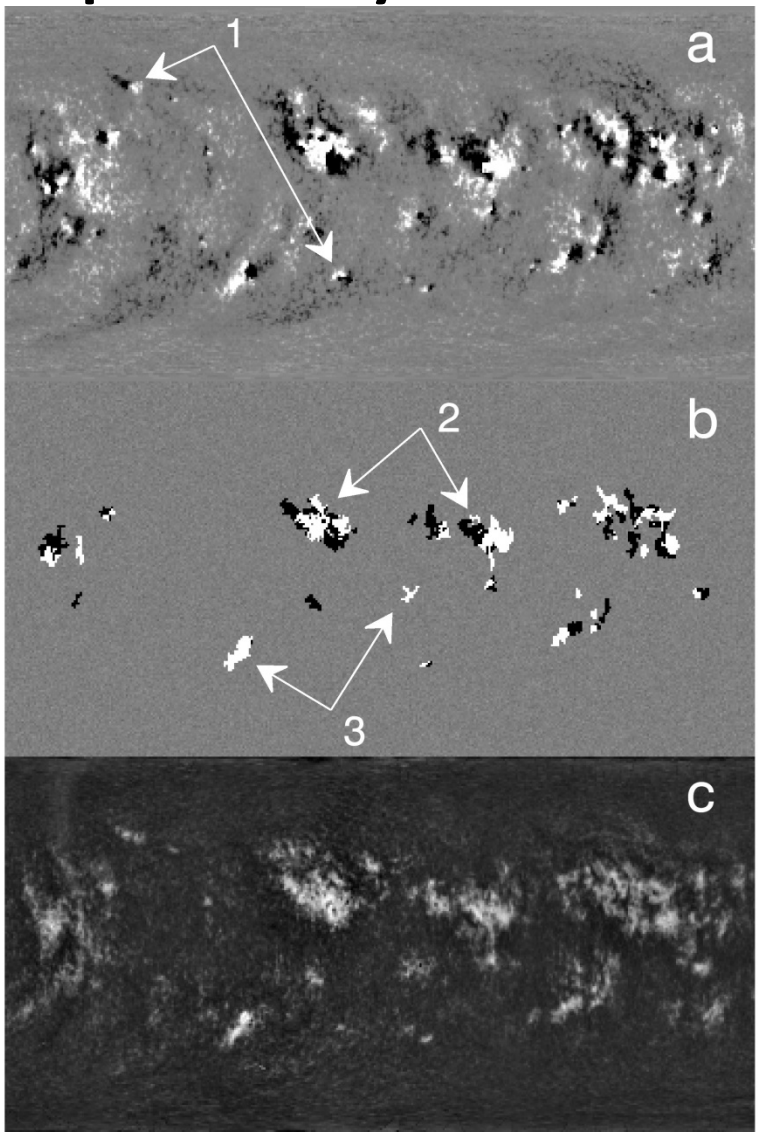
Pevtsov et al (2016)

How about polarity of magnetic field ?



MWO Sunspot Field Strength Measurements (1917-present)

Pseudo-Magnetograms (K-line + sunspot polarity measurements)



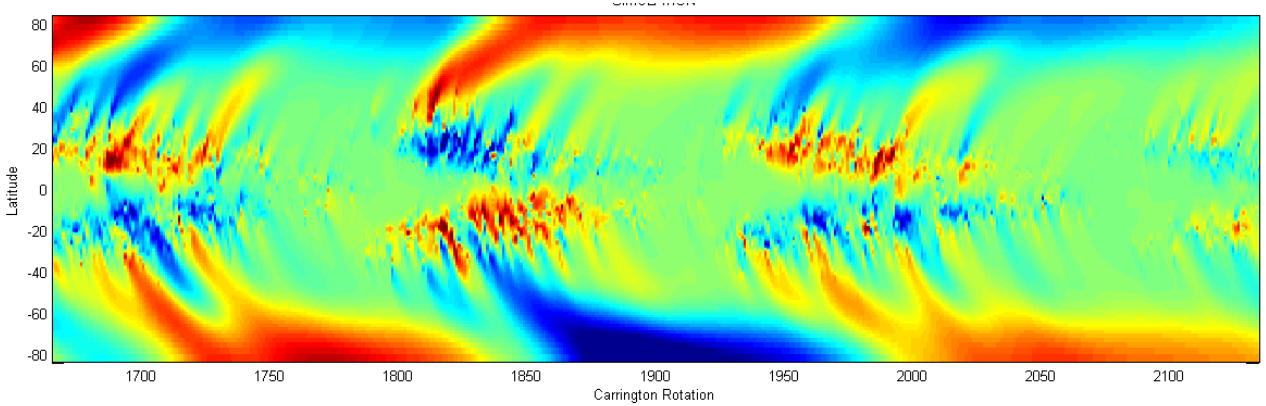
(1)- missing
(2)- good match
(3)- only one polarity

Overall – 80% agreement in pixels polarity

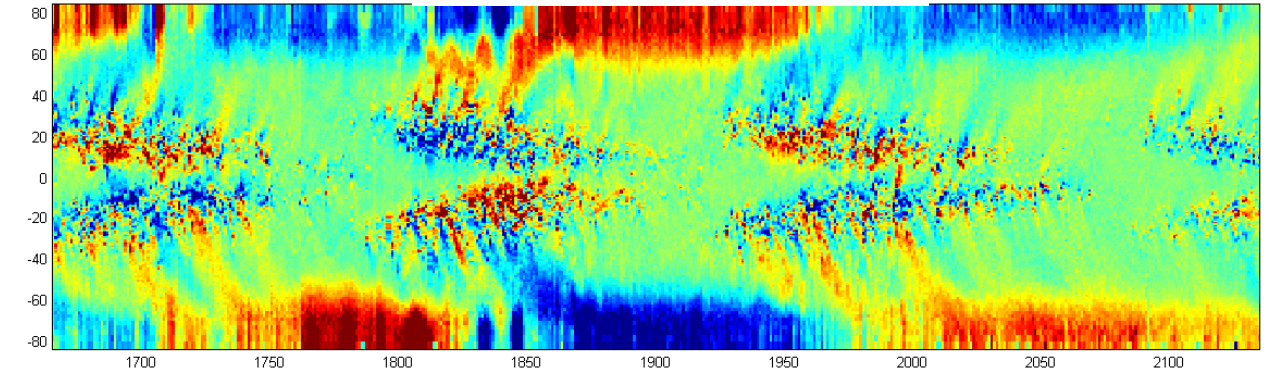
Pevtsov et al (2016)

Surface Flux-Transport Modeling

Simulations based on historical data



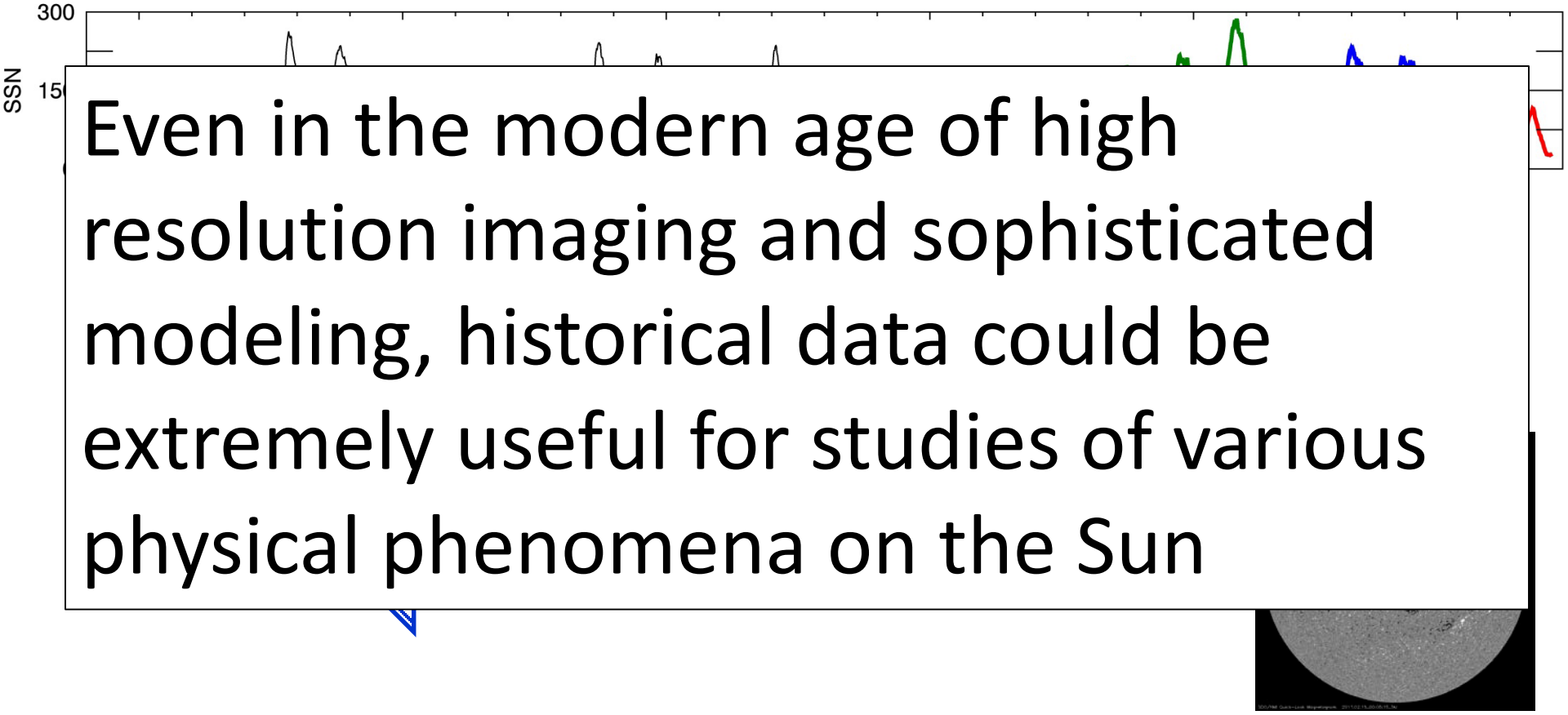
Observations from KPVT



"Evolve" magnetic field:

- Diffusion
- Meridional flow
- Differential rotation

Virtanen et al (2017)



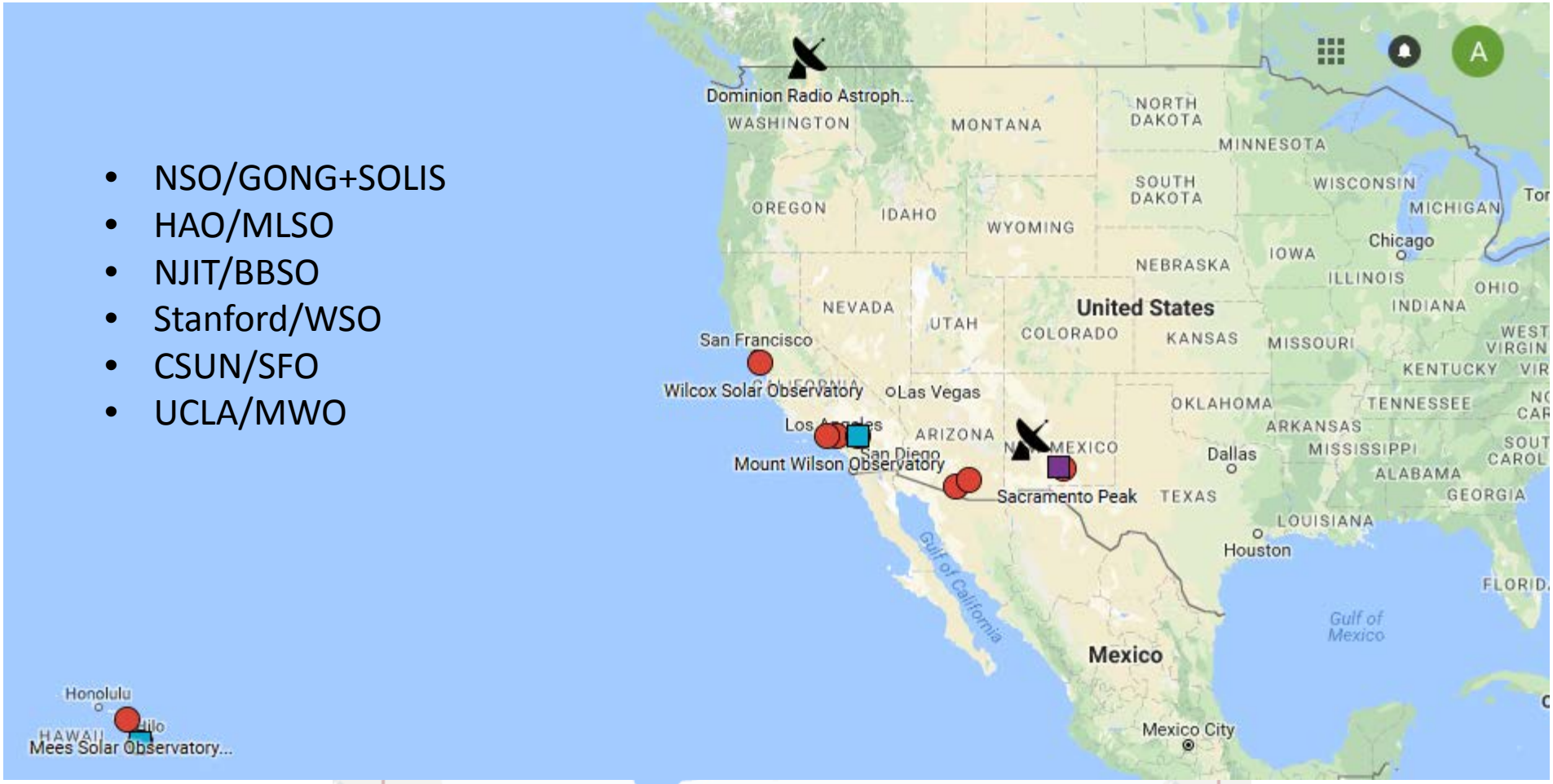
Even in the modern age of high resolution imaging and sophisticated modeling, historical data could be extremely useful for studies of various physical phenomena on the Sun

But…

- Value of synoptic data is under-appreciated
- Bibliometrics is increasingly used as a measure of importance (and funding distribution)
- There is no commercial value in solar data (and derived products do not want sharing the costs).
- Funding is declining (also, there are structural changes in funding schemes).

Solar Observatories Around the Globe

- NSO/GONG+SOLIS
- HAO/MLSO
- NJIT/BBSO
- Stanford/WSO
- CSUN/SFO
- UCLA/MWO



map

https://www.iau.org/science/scientific_bodies/working_groups/255/

Future Plans

- SPRING network (possible replacement for GONG): 4-6 sites, 1-m telescopes, SOLIS-type mount, multi-wavelength helioseismology and vector magnetography

Some current issues

- 3-5 year funding cycle is too short for synoptic programs
- Strong emphasis on immediate scientific return (most in US are grants funded)
- Lack of long-term planning (no well-defined goals, diminishing funding, aging facilities).
- Long-term datasets are often *ad hoc* collections.
- Lack of coordination between national programs/ observatories (non-uniform/ duplicate data).
- No critical evaluation (what do we need to observe, what is missing etc).
- Data preservation

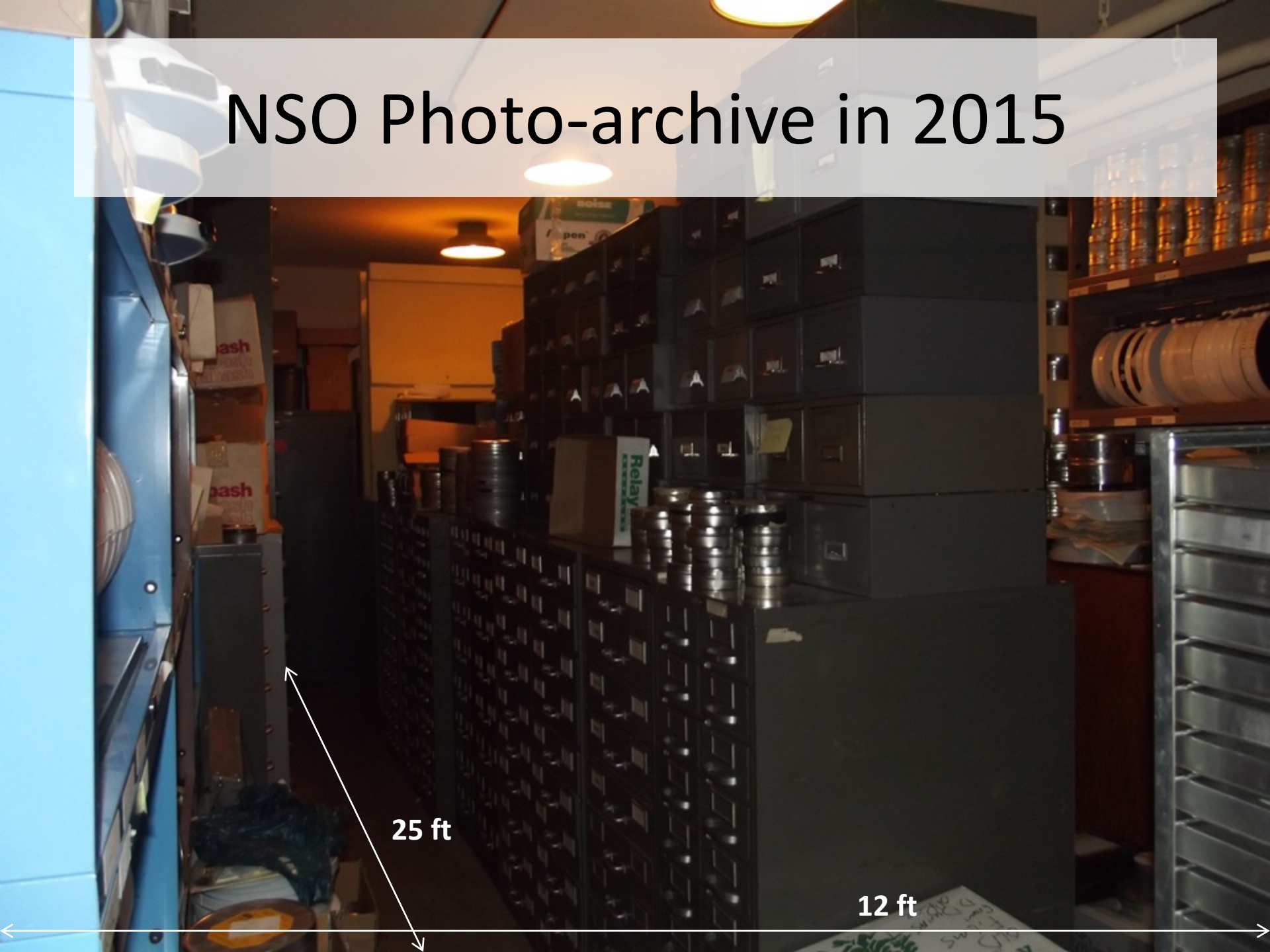
What to do with synoptic data?

- Current *modus operandi*: host institute “takes care of its own data”
- Data may be hard to find and access (FTP, “ask for data”, VSO).
- No clear long-term plan for data preservation (loss of data at the end of project, outdated file formats).
- Examples: MWO (CaK), NSO (coronal data, Kitt Peak spectral line profiles, sun-as-a-star, solar disk center (W. Livingston data), SP K-line monitor spectra), HK MWO stellar dataset, observations from Haleakala Solar Observatory/UH
- NOAA – emphasizes space weather, lacks sufficient

Historical orphan data

- Paper (hand drawings, computer printouts/rolls, observing logs)
- Photographic data (film, plates)
- Electronic records (tapes, disks, CDs etc).

NSO Photo-archive in 2015




Coronal spectra


H-alpha FP and prominences


1967
spectroheliograms


Coronal scans

A joint expedition of the High Altitude Observatory, Sacramento Peak Observatory, and the National Bureau of Standards obtained slitless spectrograms of the flash spectrum at the February 5, 1962, total eclipse of the Sun. The spectrograms covered the wavelength range of about 3200 to 9100 Å with a height resolution of 100 km.

Lack of Dedicated Funding for Data preservation

- Converting to electronic format (scanning, creating metadata): ex. BBSO and NSO flare patrol (late-1950th-2002), sunspot drawings (NSO and MWO), spectroheliograms
- No funding for follow-up work (meta-data, calibration)

What needs to be done (observations)

- Critical evaluation of synoptic observations
- Develop plan for replacing instruments for maintaining critical datasets (set of automated stations?)
- Establish new funding models (longer funding periods for synoptic programs, inter-agencies funding)
- Other “working” aspects (e.g., format, version of data reduction, clear description of data and reduction).

What needs to be done (data preservation)

- Create comprehensive list of data to preserve and identify funding sources
- Develop clear path for preserving the data and identify responsible parties: e.g., NASA-like (1) instrument archive, (2) long-term archive, (3) final storage
- Realistic long-term data preservation plans must be required for all future synoptic programs

What needs to be done (international collaboration)

- Leverage international collaboration (share expenses and responsibilities, prevent duplication, data sharing policies/international agreements)
- Ensure strong support from international societies (IAU, SCOSTEP/ICSU, WMO etc).

Recent developments

- Trying “joining forces” with astronomy community on data preservation
- Starting discussions on closer international collaborations (meeting in Goettingen, white paper for U.N. presentation).

How synoptic observations can/will shape new frontiers of discovery

- Data collected now enable future research (Galileo vs. space weather effects)
- Science: critical knowledge about long-term changes in sun's activity (as a natural system, e.g., what changes occur prior to major shifts in activity levels, how solar dynamo recovers from grand minima)
- Technology: there might be an opportunity for developing durable, reliable, autonomous systems that would benefit the long-term synoptic observation programs.

Existing resources

- NSF Earthcube, NSF RFI on existing and future scientific community needs for mid-scale research infrastructure.
- Several international/national grassroots initiatives → “join forces” with astronomy community on data preservation
- Support from international societies (IAU, SCOSTEP, etc).
- New approaches for improving the data recognition (DOI, DataCite, CrossRef, adopt (?) USGS practice for their stations).
- Three worldwide organizations dedicated to science data: World Data System (WDS), Committee on Data for Science and Technology (CODATA), Research Data Alliance (RDA).

https://www.iau.org/science/scientific_bodies/working_groups/255/

Inter-Division B-E WG Coordination of Synoptic Observations of the Sun — **Functional**

Description

The mission of this working group is to facilitate international collaboration in synoptic long-term solar observations, which includes past, current, and future synoptic programs, preservation, calibration, and access to synoptic solar data products. The working group provides a forum for discussion of all issues relevant to synoptic long-term observations of the Sun including (but not limited to) coordination between synoptic programs in different countries (both in respect to exchange of information and planning for future synoptic programs) and a proper calibration of historical data from different sources (e.g., sunspot drawings, CaK plage indices, magnetic field measurements etc).

Links:

- 2016 activity by IAU Inter-Division B and E WG on Coordination of Synoptic Observations of the Sun

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Working Group Members (55)

Under

Division B Facilities, Technologies and Data Science
Division E Sun and Heliosphere

Brief Description of WG

WG was created at the end of 2011-early 2012; in 2015 after the IAU restructuring, it became "*Inter-Division B and E WG on Coordination of Synoptic Observations of the Sun" (functional).*

Co-Chairs: Frederic Clette (Belgium) and Alexei Pevtsov (USA)

WG web pages:
http://www.iau.org/science/scientific_bodies/working_groups/255/

http://www.nso.edu/IAU-Com12 - direct link to group page

SPACE SCIENCE & SPACE PHYSICS Opinion

To Understand Future Solar Activity, One Has to Know the Past

Short-term funding strategies present serious problems for programs like solar activity studies, where observations and analysis span

https://eos.org/opinions/to-understand-future-solar-activity-one-has-to-know-the-past

Thank you for your attention