Past solar data

Status, recovery and future preservation

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Outline

- Types of solar data + examples
- Specific weaknesses and risks
- Broader data problems and challenges:
  international science data organizations
- Business models for solar repositories
- Key questions

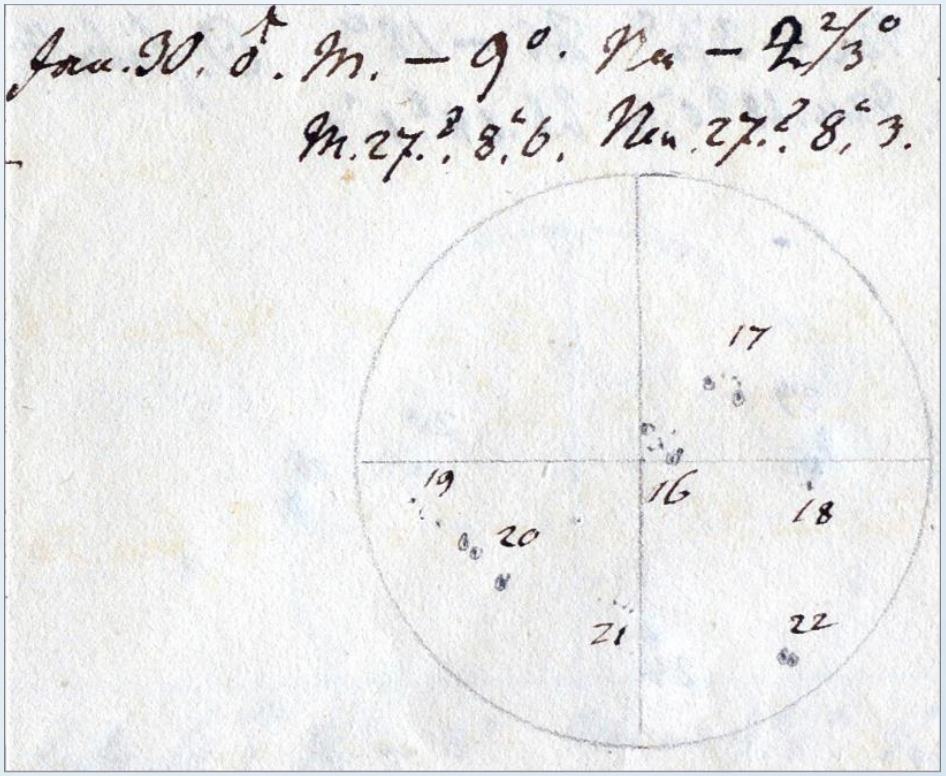
What kind of data ?

- Paper documents (printed or handwritten):
  - Drawings: sunspots, corona (eclipses)
  - Tables: sunspot counts, catalogues
  - Logbooks and reports
- Photographic images (1874 to ~2010):
  - White-light photosphere (sunspots, photometric)
  - Filtergrams/spectroscopic rasters: H-alpha (flare patrol) , CaII-K
  - Magnetograms (Mount Wilson)
  - Spectra
  - Solar eclipses (corona)
- Electronic images (electron tube to CCD, after ~1970)
- Radio (paper-roll recordings, magnetic tapes):
  - Total flux (e.g. F10.7cm)
  - 1D-disc scans or 2D images
  - Spectrograms

Historical drawings

- Staudacher, Schwabe: digitization by R. Arlt (AI Postdam)
- Data not accessible: "ask the author"

(Historical drawings resource page http://obs.astro.ucla.edu/resource2.html)



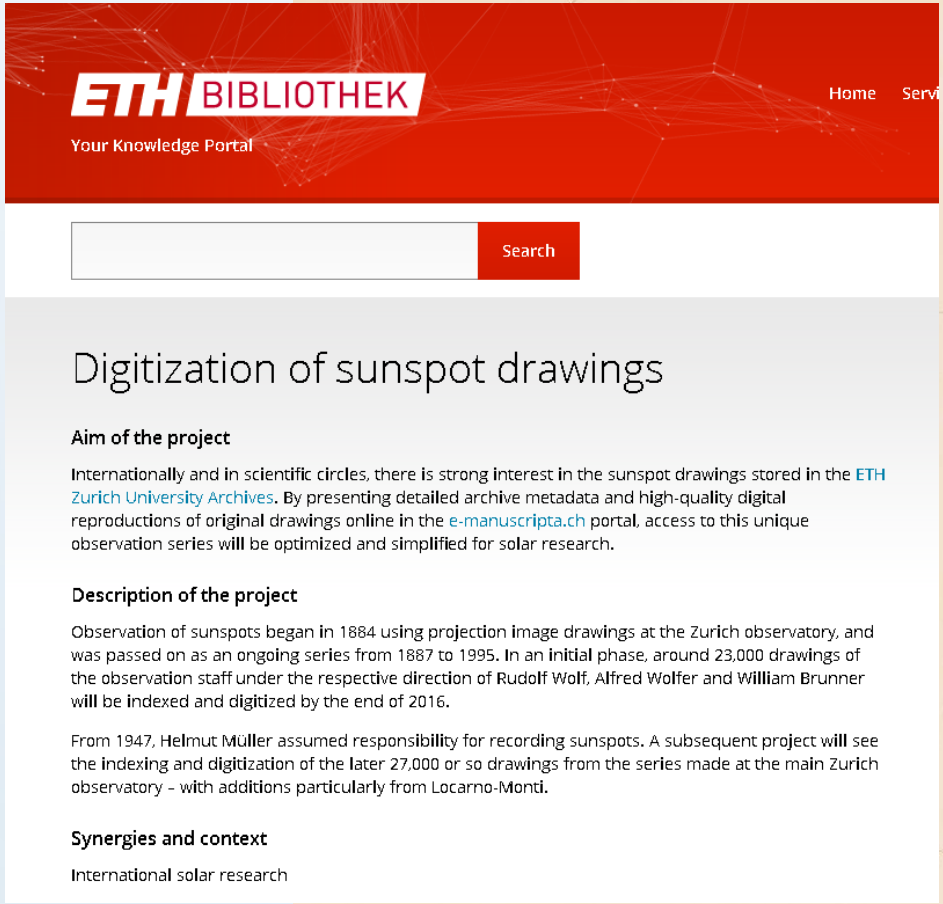
The Historical Archive of Solar Observations (HASO)

- Digital archive for sunspot drawings and related historical documents in digital form (University of Extremadura, J. Vaquero): http://haso.unex.es/

- Revised group number database *(Vaquero et al. 2016)*: catalog of raw sunspot counts by historical observers (1610-2015)

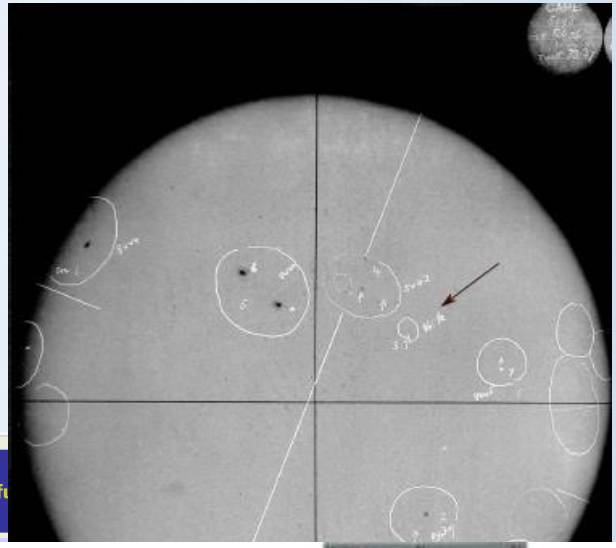
Zurich sunspot drawing collection

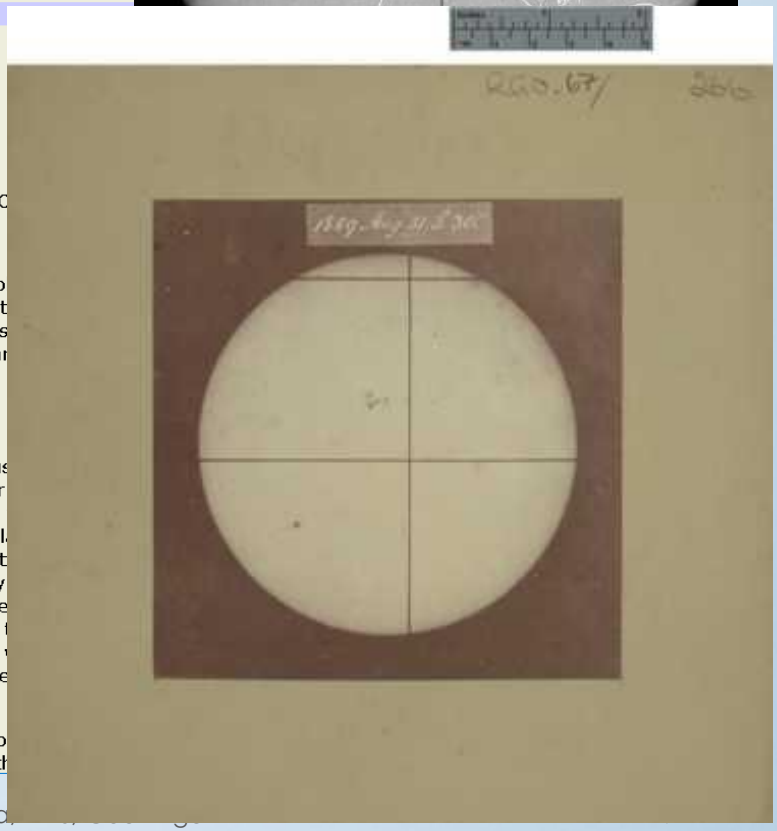
- Drawing collection (1882-1980):
  - Digitization started in 2016, ETH Library (Swiss federal program)



Greenwich photographic collection

- Cambridge Library (D.Willis et al. 2016) :
  - discovery.nationalarchives.gov.uk/details/r/C15306
  - https://janus.lib.cam.ac.uk/db
  - After 1976: Debrecen (A.Ludmany, T.Baranyi)
- Loss: all plates before 1918 damaged beyond use during WWII (only contact prints remaining).





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RGO Archives contains:

<-- See earlier

RGO 45 Papers of John Guy Porter
RGO 46 Papers of Leslie John Comrie
RGO 47 Anglo-Australian Telescope papers
RGO 48 Papers of the Radcliffe Observatory
RGO 5 Papers of John Pond
RGO 50 RO and RGO Solar Plates
RGO 51 RO and RGO Solar Plates Contact Prints
RGO 52 The Astronomical Almanac
RGO 54 Papers of William Ellis
RGO 55 Papers of the Board of Visitors
RGO 56 Papers of Herstmonceux Conferences

See later -->

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RO and RGO Solar Plates

Title	RO and RGO Solar Plates
Reference	GBR/0180/RGO 50
Creator	Royal Observatory, Greenwich; Royal Greenwich C
Covering Dates	1918–1979
Extent and Medium	20374 glass plates; 54 contact prints, prints or p photoheliographs; 33 positive films; 7 cellulose it sheets; glass plate/photograph/paper; The plates India are in poor condition. Many show mould dar
Repository	Royal Greenwich Observatory Archives

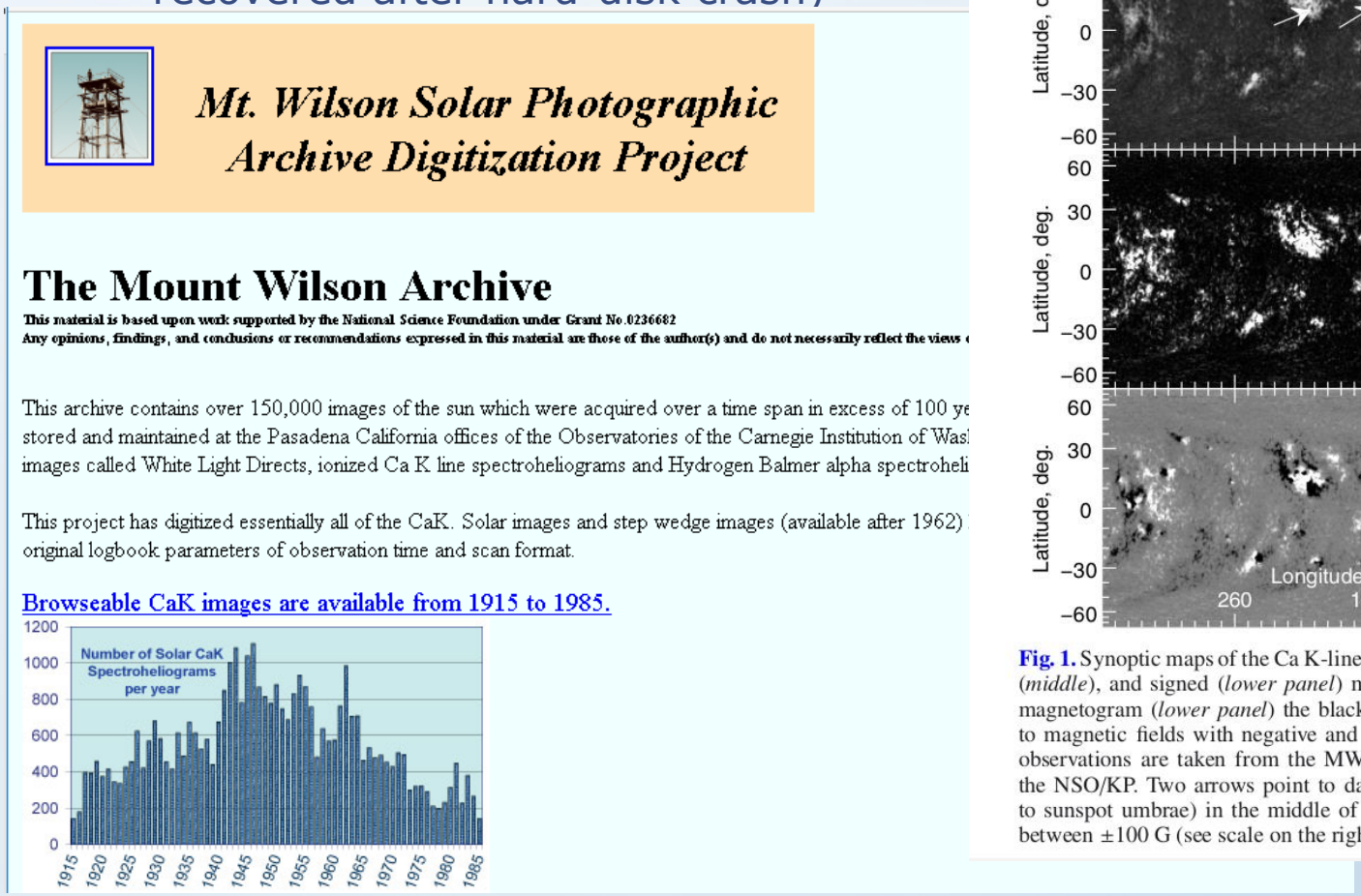
Content and context

Regular observations of the sun were begun at Greenwich becaus fluctuation of the Earth's magnetic field with sunspots and other greatly enhanced interest given to the observations when it was frequency of magnetic disturbance was due to changes taking pl Two observers, one working on spots on the sun and the other st magnetic needle, independently found that the phenomena they cycle and that when the cycles were compared they proved to be the spots on the sun became more numerous the daily swing of t stronger and as they diminish the needle moves more feebly. It supplement the Magnetic Observatory by one devoted to the dire photography.

Observations of the sun had been made during the 1860s on a p Warren De La Rue operated from the Kew Observatory. Early in th

Mount Wilson photographic archive (CaII-K)

- www.astro.ucla.edu/~ulrich/MW_SPADP/ *(site inaccessible!)*
  re-digitization*(L. Bertello et al. 2010)*:
  - Escaped full loss (single copy of raw data recovered after hard-disk crash)



Mt. Wilson Solar Photographic Archive Digitization Project

The Mount Wilson Archive

This material is based upon work supported by the National Science Foundation under Grant No.0236682
Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views

This archive contains over 150,000 images of the sun which were acquired over a time span in excess of 100 ye
stored and maintained at the Pasadena California offices of the Observatories of the Carnegie Institution of Was
images called White Light Directs, ionized Ca K line spectroheliograms and Hydrogen Balmer alpha spectroheli

This project has digitized essentially all of the CaK. Solar images and step wedge images (available after 1962)
original logbook parameters of observation time and scan format.

Browseable CaK images are available from 1915 to 1985.

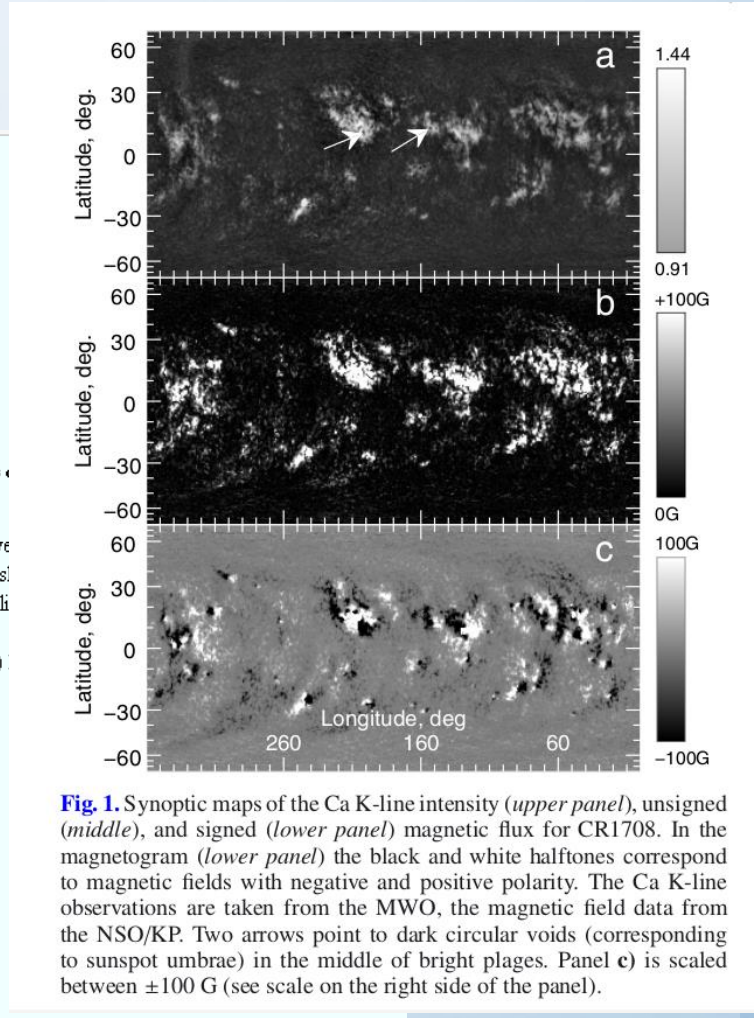
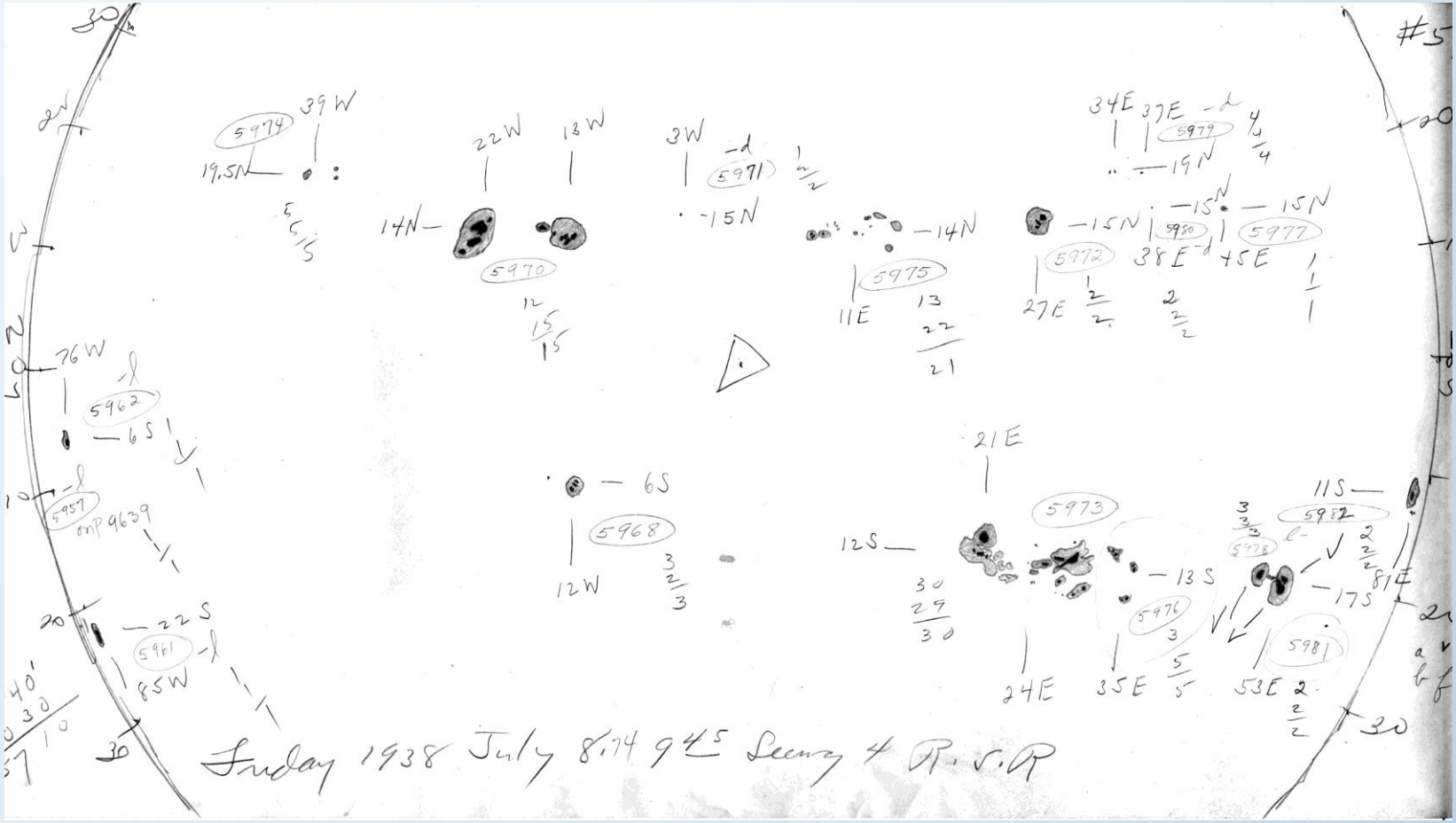


Fig. 1. Synoptic maps of the Ca K-line intensity (*upper panel*), unsigned (*middle*), and signed (*lower panel*) magnetic flux for CR1708. In the magnetogram (*lower panel*) the black and white halftones correspond to magnetic fields with negative and positive polarity. The Ca K-line observations are taken from the MWO, the magnetic field data from the NSO/KP. Two arrows point to dark circular voids (corresponding to sunspot umbrae) in the middle of bright plages. Panel **c)** is scaled between ±100 G (see scale on the right side of the panel).

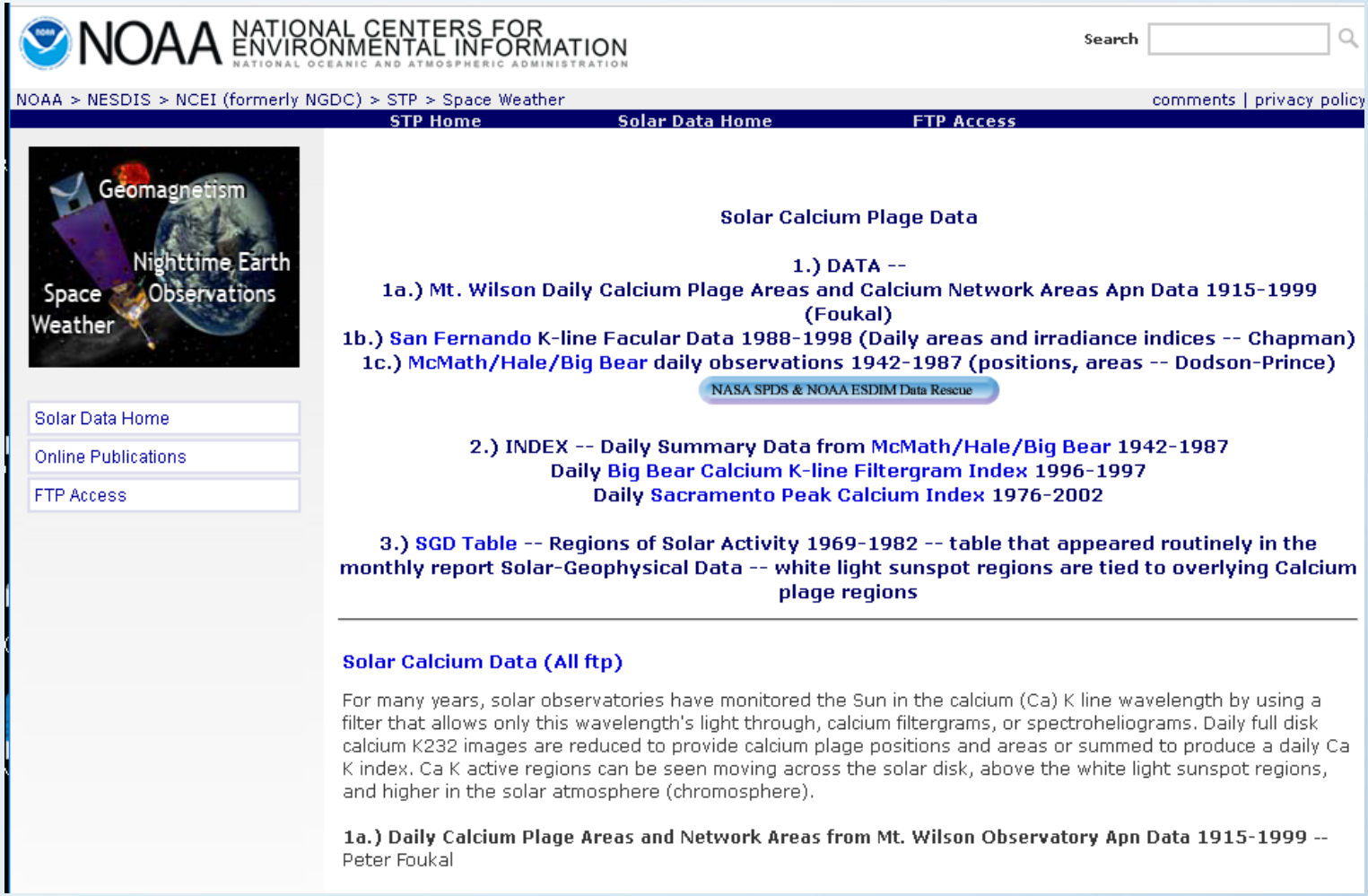
Mount Wilson sunspot Drawings

- Simple FTP: ftp://howard.astro.ucla.edu/pub/obs/drawings/



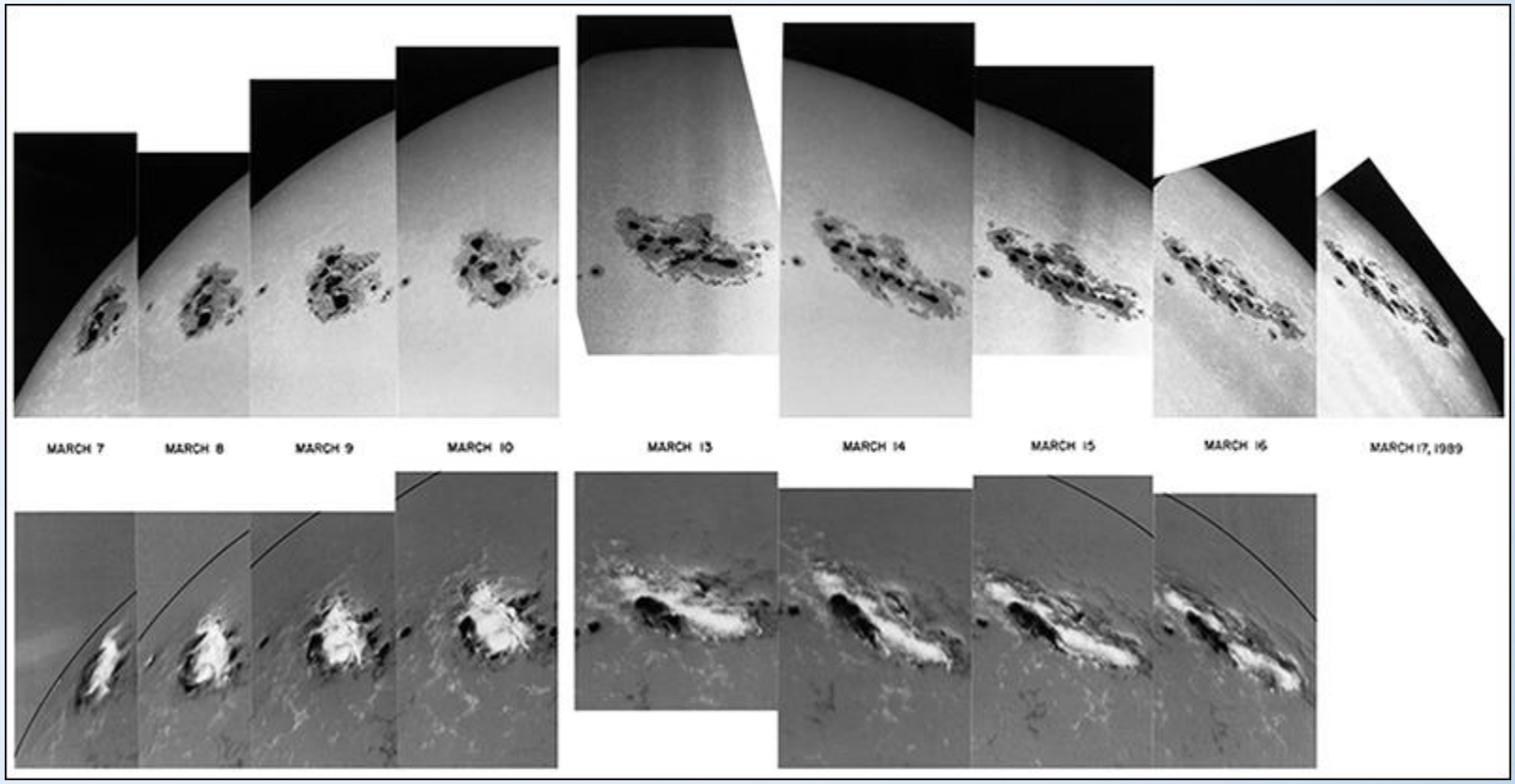
Mount Wilson catalogs and indices

- Distribution through a central platform: NOAA-NCEI



NOAO photographic archive

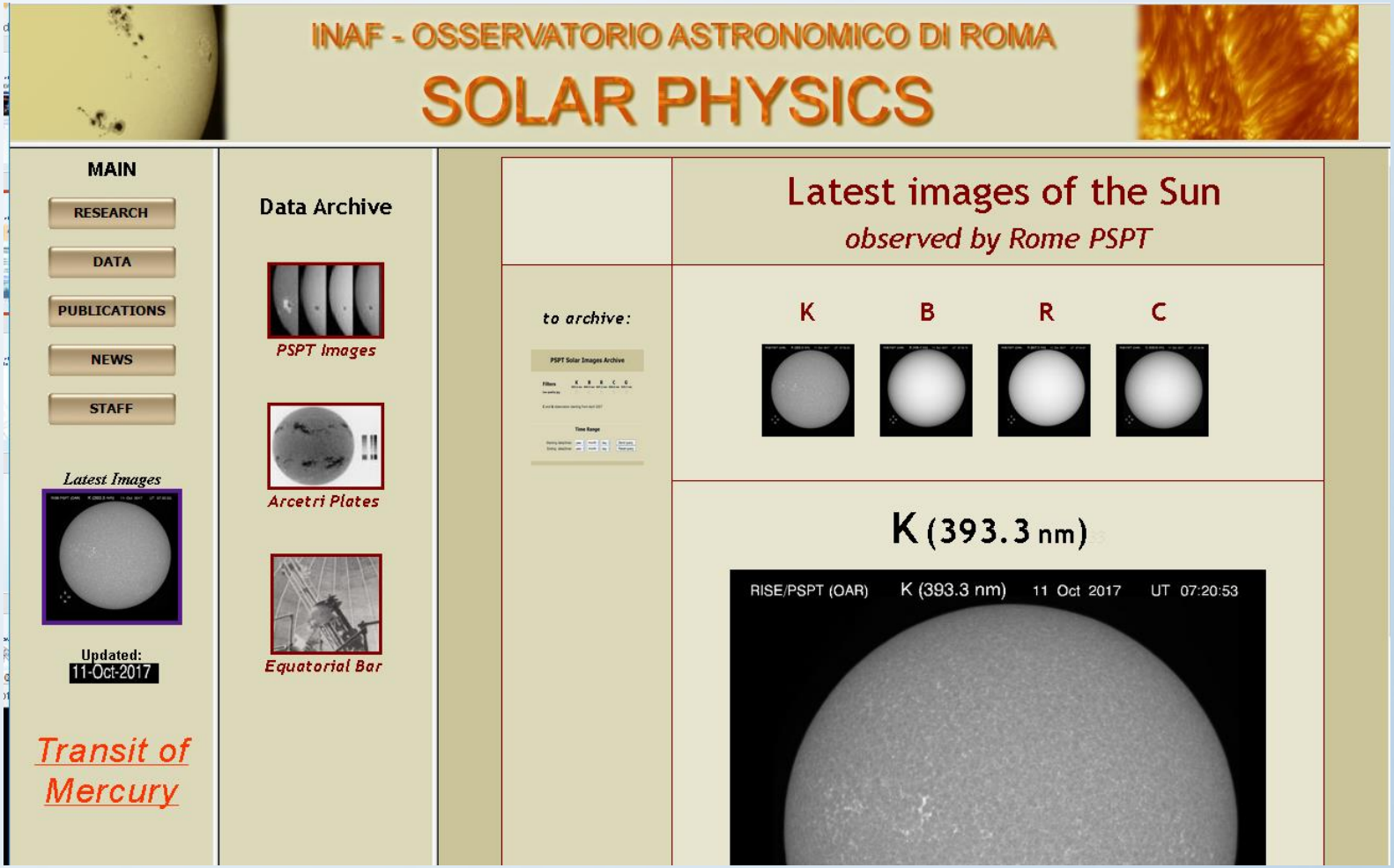
- http://archive.noao.edu/home/main:
  filtergrams, magnetograms



7-17 march 1989 (NOA0/AURO/NSF)

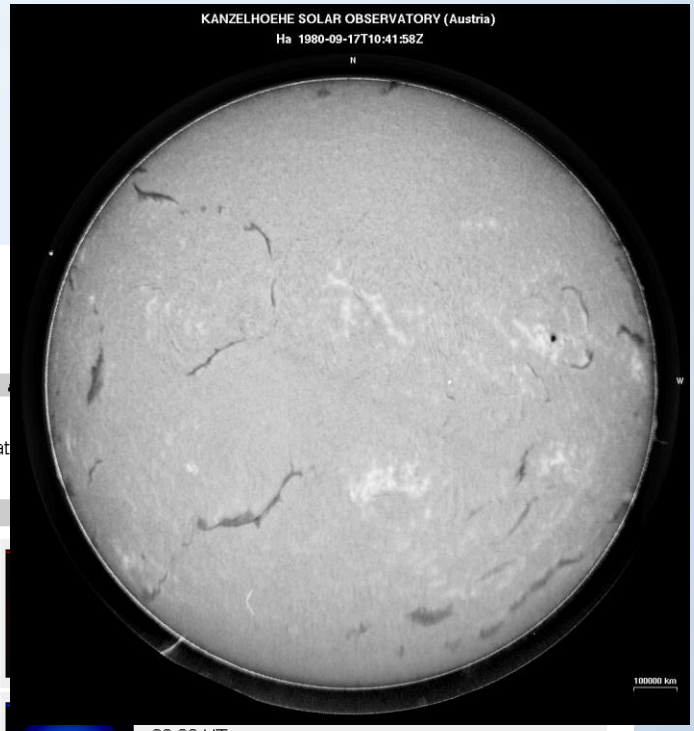
PSPT CaII K and photospheric archive

- www.mporzio.astro.it/solare/



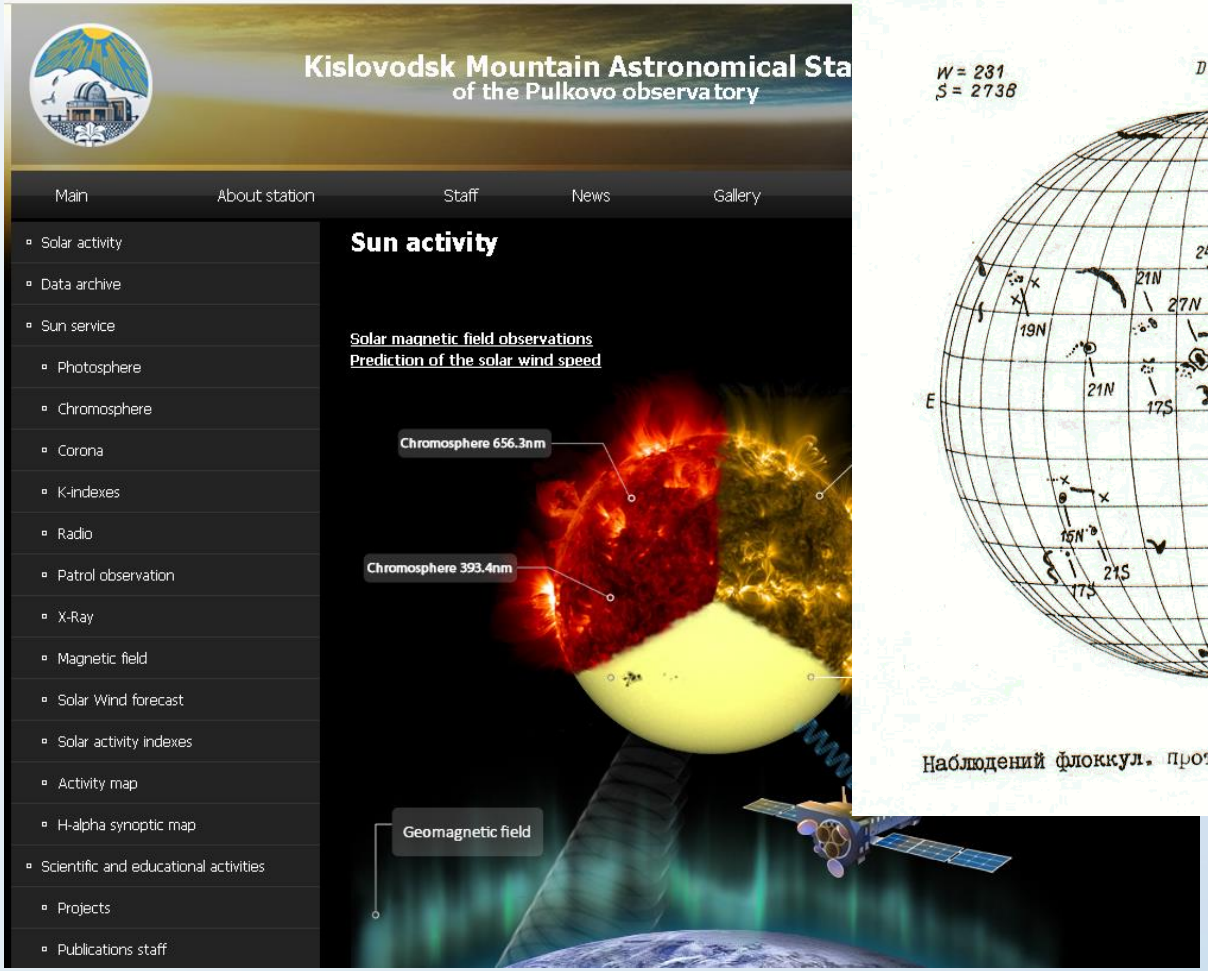
Kanzelhöhe CESAR

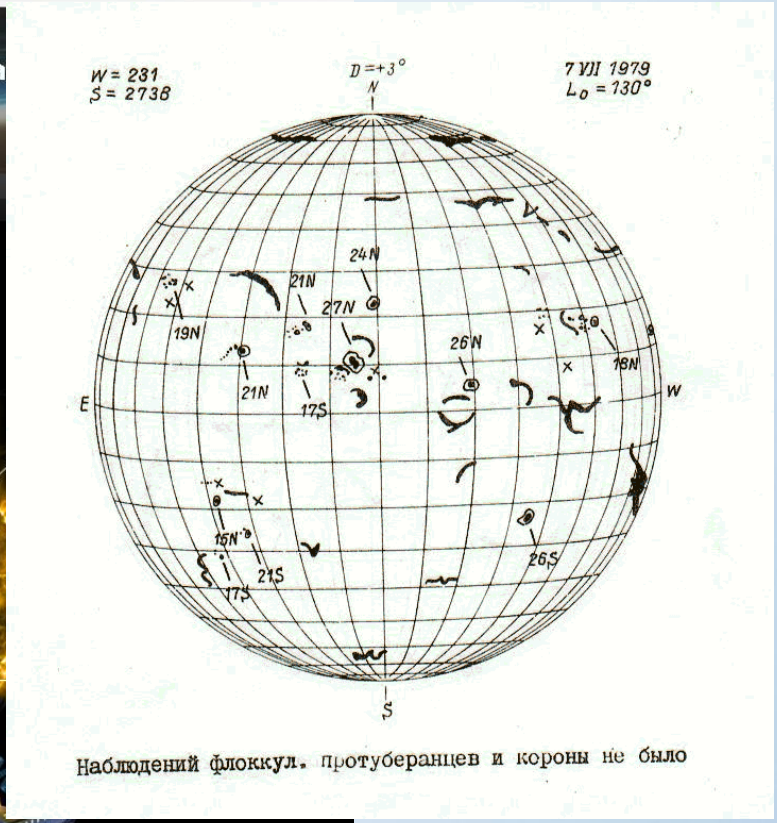
- cesar.kso.ac.at/: drawings, Hα images



Kislovodsk Mountain Astronomical Station

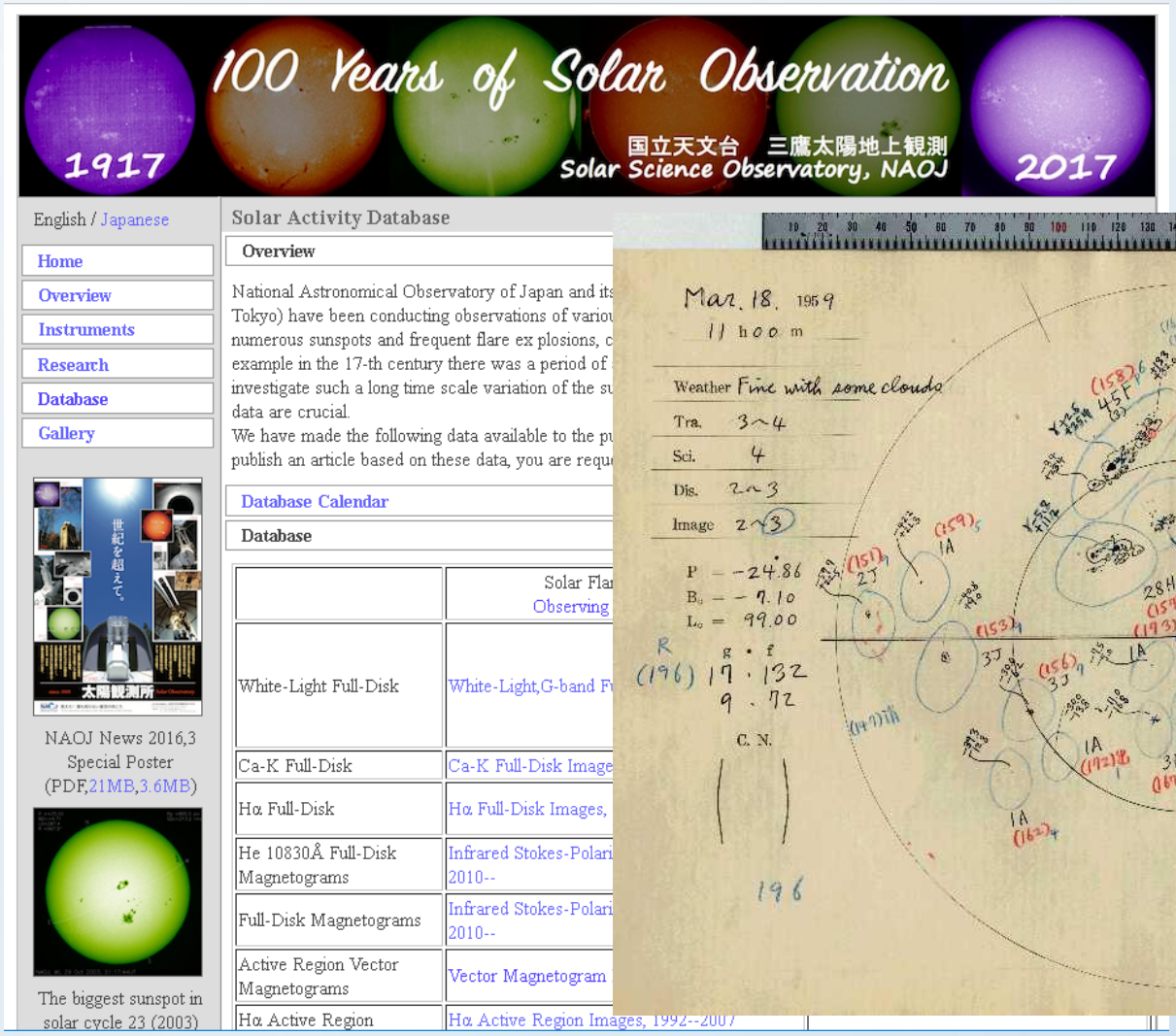
- solarstation.ru: sunspot, Hα-Ca feature catalogues and maps





NAOJ drawing and CCD image archive

- http://solarwww.mtk.nao.ac.jp/en/database.html



Multi-station data portals: BASS2000

- bass2000.obspm.fr: Paris-Meudon, Pic-du-Midi, Coimbra, USET-Brussels

Issues and risks

Weaknesses

- Isolated initiatives:
  - by individuals or single institute
  - No coordination or common standards
  - ⇨ Long-term storage depends only on local resources of a single hosting institute.
- Low accessibility and discoverability:
  - Data not accessible in-digital form
  - Basic or no on-line browsing tools (FTP)
  - ⇨ Users reluctant to spend efforts on the time-consuming and "invisible" data recovery
- Data at risk!
  - Improper document storage conditions
  - Important data falling into oblivion:
    - Disappearance of know-how as dedicated staff is not renewed

⇨ Most problems resulting from:

- Minimal or no funding for data curation work (one-person teams)
- Disappearance of long-term structural funding schemes

Issues for **paper documents**

- Assets:
  - Information accessible without equipment (visual reading)
  - Permanently decodable (no compression or coding layer)
- Risks:
  - Slow paper and ink degradation (acid paper)
  - Accidental destruction (single copy): fire, floods
  - Archives maintained by individual scientists in local institution:
    - loss of know-how after retirements, etc.
    - Data loss (trashing of archives considered as obsolete)
- Inaccessible to direct scientific exploitation:
  - Digitization required:
    - **Scanning**: fast step, ensure protection against risks
    - **Encoding (tables) or measuring (drawings)**
  - Dispersed and non-discoverable:
    - Original historical documents scattered in their home institutions, libraries
    - Deep storage and lack of metadata
  - Restricted or paying access policy in academic libraries (property)

Issues for **photographic documents**

- Assets:
  - Information accessible without equipment
  - Permanently decodable/measurable (no compression or coding layer)
- Risks:
  - Slow degradation (humidity, mold, delamination): improper storage
  - Accidental destruction (single copy): fire, floods
  - Archives maintained locally in the host institution: loss of know-how, changes in institution priorities
  - Loss: trashing of collections or isolated plates considered as obsolete
- Inaccessible to direct scientific exploitation:
  - Digitization required:
    - **Scanning (photometric quality)**: ensure protection against risks
    - **Calibration**: missing metadata (e.g. emulsion type and properties)
      - (Exploitation similar to other digital images)
  - Dispersed and non-discoverable:
    - Original historical documents scattered in their home institutions

Issues for old **digital-born data**

- Assets:
  - Data already in digital form (ready for computer processing)
  - Data sets often documented (readme files) and discoverable
- Risks:
  - Slow media degradation (magnetic tapes, CDs, DVDs, hard disks)
  - Accidental destruction: media erased, fire, floods
  - Archives maintained locally in the host institution: loss of know-how, changes in institution priorities
  - Loss (uncatalogued media considered as obsolete)
- Long-term readability of the archived data:
  - Data in old compressed form
  - Obsolete file formats (sometimes proprietary): unsupported by newer software
  - Obsolete media (no more readers)

⇨ Need for an active periodic transfer to new media/formats.

Low and shrinking funding: causes

- Funding limited to short-term projects with immediate return
  - Requirement of immediate identifiable science return:
    excludes long data recovery projects
  - Political attraction for Big Science (big data):
    ignores old small-volume high-significance data sets
- Competition-based science policy
  - Quick return, mainstream topics (e.g. space weather)
  - Deters young scientists ("slow science" kills your career!)
- Unidimensional science productivity criteria:
  - Bibliometry as unique measure
    - Data production not considered as a true scientific activity
  - Science as driver of technology and economy:
    - Past data only require off-the-shelf commercial equipment/software

⇨ **Long-term data recovery and maintenance is out of the picture**

Typical "survival" solutions

- End-of-career project of senior scientists:
  - Small side-budgets (from annual dotation of host institute)
  - One-shot money for small investments from project participations
  - Use of volunteers, part-time colleagues, student summer jobs
  - Part-time side work >>> slooooow

  ⇨ **Highly precarious** (homogeneity and completion not guaranteed)
- Governmental digitization programs:
  - Often destined to museums and ministries:
    - Paper documents: texts
    - Pieces of art (cf. Europeana)
  - Special quantitative techniques are not foreseen (e.g. densitometers)
  - Focus on commercial return (public-private contracts):
    - On-line access to popular items (paintings, etc.) for a fee
  - Focus on data/artifact preservation:
    - Survival to steady decay
    - No more manipulation of the original

  ⇨ **No budget for measurements or catalog construction**

Broader data problems and challenges

International science data organizations

A much broader problem

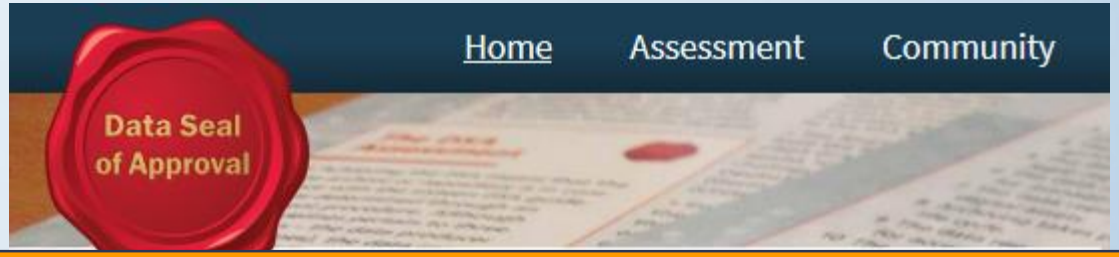
- Three worldwide organizations dedicated to science data
- **World Data System, WDS** (ICSU/UNESCO) since 2008: www.icsu-wds.org
  - Coordination and accreditation of World Data Centers (data repositories & services, origins back in 1957)
  - Focus on identifying, creating, and sustaining institutions that provide stewardship, long-term preservation, and access to data.
- **Committee on Data for Science and Technology, CODATA** (ICSU) since 1966: www.codata.eu
  - Members: academies, science councils, international scientific unions
  - Focus on data technologies and standards: framework of standards, agreements and protocols that enable data to be shared and reused.
    - Data citation standards and practices
    - Interoperability standards
    - Citizen science and crowdsourced data

A much broader problem

- **Research Data Alliance RDA** since 2013:
  www.rd-alliance.org
  - Membership: private & non-profit organizations (publishers), individuals
  - Focus on data curation practices and policies:
    - **Data discoverability** (permanent identifiers)
    - Data security, versioning, interoperability
    - **Data repositories**, metadata standards, disciplinary data registers
    - **Data rescue, data service sustainability**
    - **Long-tail data**
    - Legal and ethical aspects (Health and social sciences)
- Organization of **International Data Weeks** (Sept. 2016, Denver, USA): synergies, common initiatives:
  - Challenge of Big Data
  - Trans-disciplinary data standards and interoperability
  - **Data traceability and permanent identifiers** (CrossRef, DataCite)

Some initiatives under development

- Generalization of **permanent identifiers** (DOI codes):
  - Uniquely identifies an item regardless of its physical status/location
  - Also for identification of data sets
  - Tracking of different versions
- **Data Seal of Approval** (DSA):
  https://www.datasealofapproval.org
  - Created by the Data Archiving and Networked Services (DANS, Netherlands)
  - Focused on **data curation practices**
  - Now adopted by WDS as base for future accreditation of World Data Centers



Value of data production = peer-review publications

Putting solar data in a broader context

- Advantages:
  - Not reinventing the wheel: adopting standards, practices already in development for other domains
  - Compatibility and interoperability with other types of data
  - Leveraging effect: benefiting from the weight of a large international data community
- Disadvantages:
  - Small solar community:
    - Limited influence on adopted standards (not well adapted to the case of solar physics?)
  - Large bureaucratic organizations:
    - Heavy decisional process
  - Emphasis on advanced data techniques (large repositories) and on service accreditation:
    - Data rescue is secondary.

Putting solar data in a broader context

- Risks for small historical data repositories:
  - Higher requirements on data services (advanced standards):
    - More work for already understaffed services
    - Lack of existing know-how in the latest data technologies (small teams)
  - Organization working only as specifying bodies:
    - No corresponding support or funding for the implementation
- Only data curation standards:
  - Science validation of the data is under responsibility of disciplinary science unions

Business models

- **Classical institutional repository:**
  - Funding, staff and logistic provided by a hosting institution (University, Governmental research)
  - Funding source: running annual budgets of institutions
  - Open-access public data (no revenue)
  - **Dominant (exclusive?) model for solar data**
- **Commercial revenues from paying users**:
  - All data (typically: statistical data, geographically distributed data)
  - Or part of the data: value-added data products (mapping, etc.)
  - **Not applicable to solar data: No market**:
    - Users = small community of (non-paying) scientists
    - Indirectly feeds services to end-users (ionosphere: telecom, GNSS; magnetosphere: energy distribution, space assets)

Business models: other options?

- **Cost-recovery mechanisms**:
  - Charging licence fees for any commercial downstream service
  - Still open for all non-profit public-service uses:
    Creative Commons type of licences

- **Global funding scheme for international data services**:
  - International source: Supervising worldwide institution provides the funding to accredited services
  - Most logical solution: full superposition

benefiting science community = accreditation body = financial source

  - Primary overarching organisations for solar physics:
    - IAU
    - ICSU
    - AGU, EGU, IUGG

Questions as conclusion

- Which is the best way to standardized-browsable-discoverable multi-site archives?
  - Promoting the implementation of standards in existing local archives?
    - Which extra budget?
    - How to acquire the required technical know-how? (training?)
  - Creation/development of central repositories/portals?
    - Where and how ?
    - How to address data property issues ?
    - Will data stored in those centers have a better life expectancy?
- Local institutional solar archives: a financially sustainable business model?
  - Alternative options? Which ones?
  - Working examples?
- Solar-specific advocacy for solar archive services or integration in international data organizations?
  - Role of IAU or other scientific unions?

Thank you for your attention