
2023 Sun-Climate
Symposium
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A short history of the San Fernando Observatory and its Photometry Program

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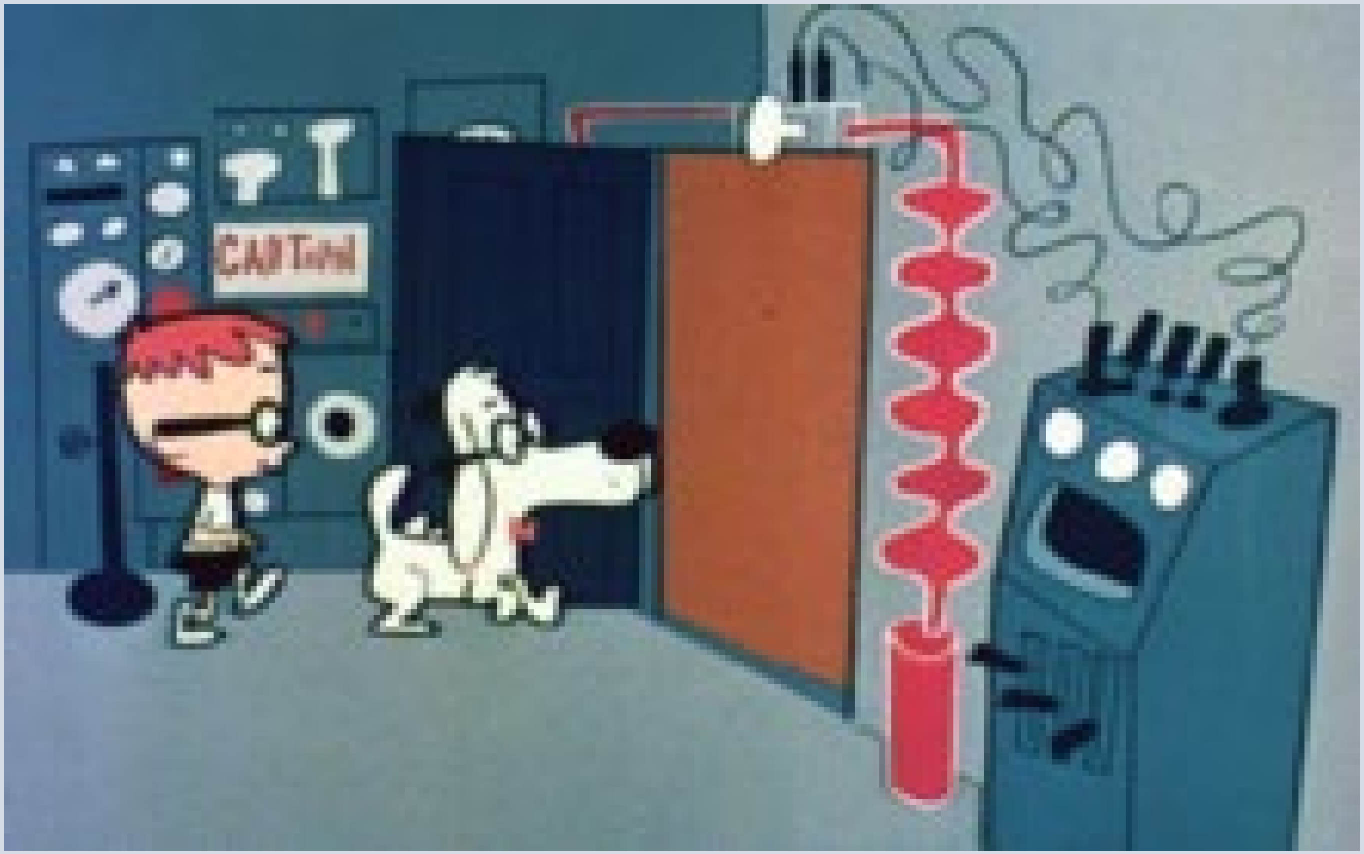
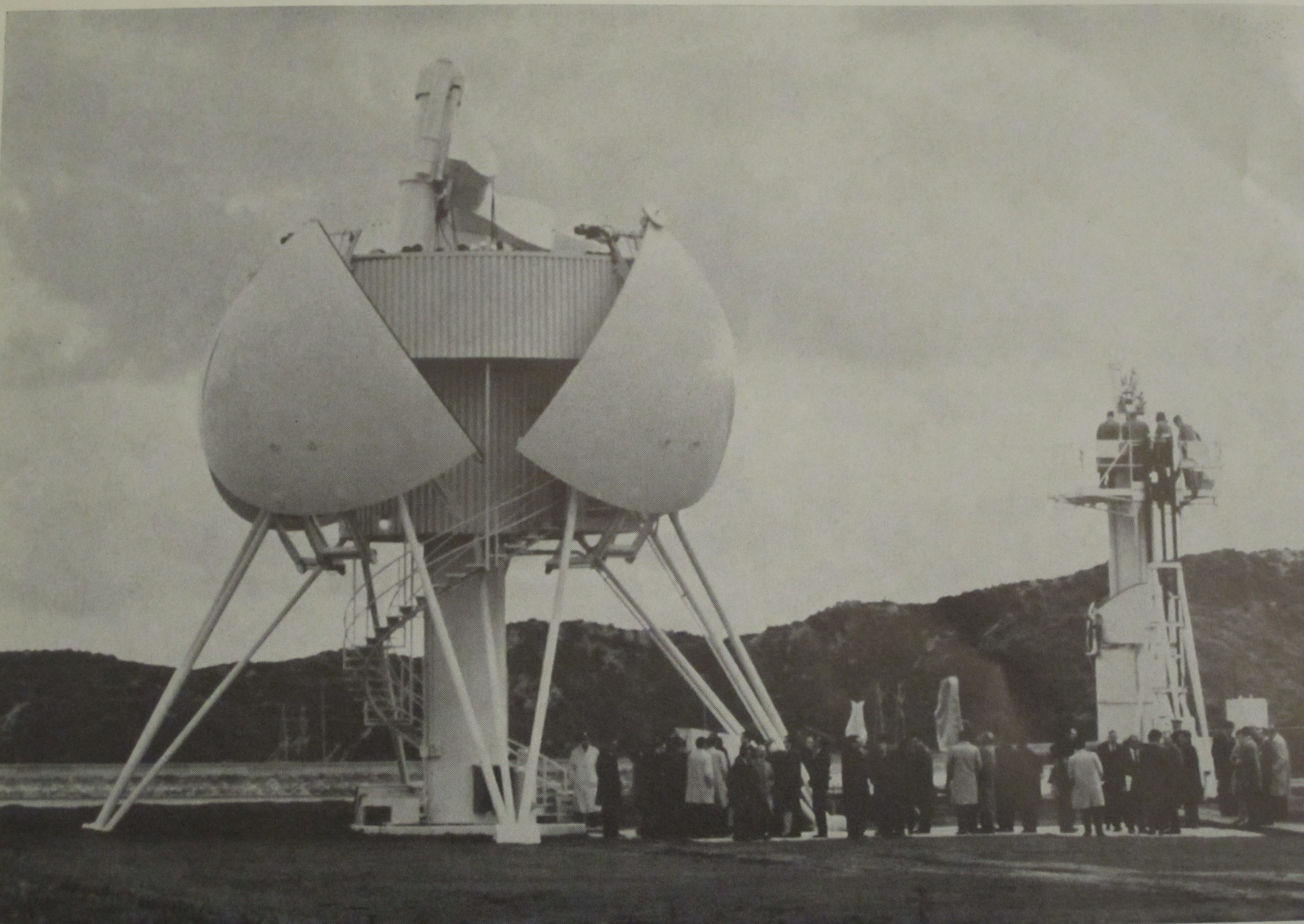
San Fernando Observatory (SFO)
California State University Northridge
18111 Nordhoff St, Northridge, CA 91330-8268

Whitney Canyon Park
Elsmere Canyon Open Space
Antelope Valley Fwy
14
5
Rice Canyon
Foothill Blvd
Saddletree Open Space
Wilson Canyon Park
Pacoima Reservoir
Michael D. Antonovich Open Space
Foothill Fwy
210
Olive View Dr
Polk St
Gavina Ave
El Cariso Community Regional Park
Roxford St
Bledsoe St
Tyler St
Sayre St
Hubbard St
Herrick Ave
Glenoaks Blvd
Bradley Ave
Gladstone Ave
O'Melveny Park
Bee Canyon Park
Balboa Blvd
Golden State Fwy
San Fernando Rd
Sylmar
Upper Van Norman Lake
Maclay St
Sesnon Blvd
Woodley Ave
Lopez Canyon Rd
7th St
Porter Ridge Park
Bradford Pl
Granada Hills North
Edgecliff Ave
Knollwood Golf Course
Tampa Ave
Reseda Blvd
4th St
5th St
Arroyo St
Porter Ranch
Aliso Canyon Park
S Workman St
San Fernando
Vaughn St
Paxton St
Granada Hills
Rinaldi St
118
405
Ronald Reagan Fwy
Pacoima
Mission Hills
Brand Park
Fox St
Granada Hills South
Wilbur Ave
Chatsworth St
Zelzah Ave
White Oak Ave
Louise Ave
Haskell Ave
Haynenhurst Ave
Hansen Flood Control Basin
Lake View Terrace
Van Nuys Blvd
Whiteman Airport-WHP
Osborne St
Arleta Ave
Devonshire St
1 mi
1 km
Map data ©2012 Google - Edit in Google Map Maker





Sky and TELESCOPE

San Fernando Observatory

In This Issue:

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Vol. 37, No. 4
APRIL, 1969
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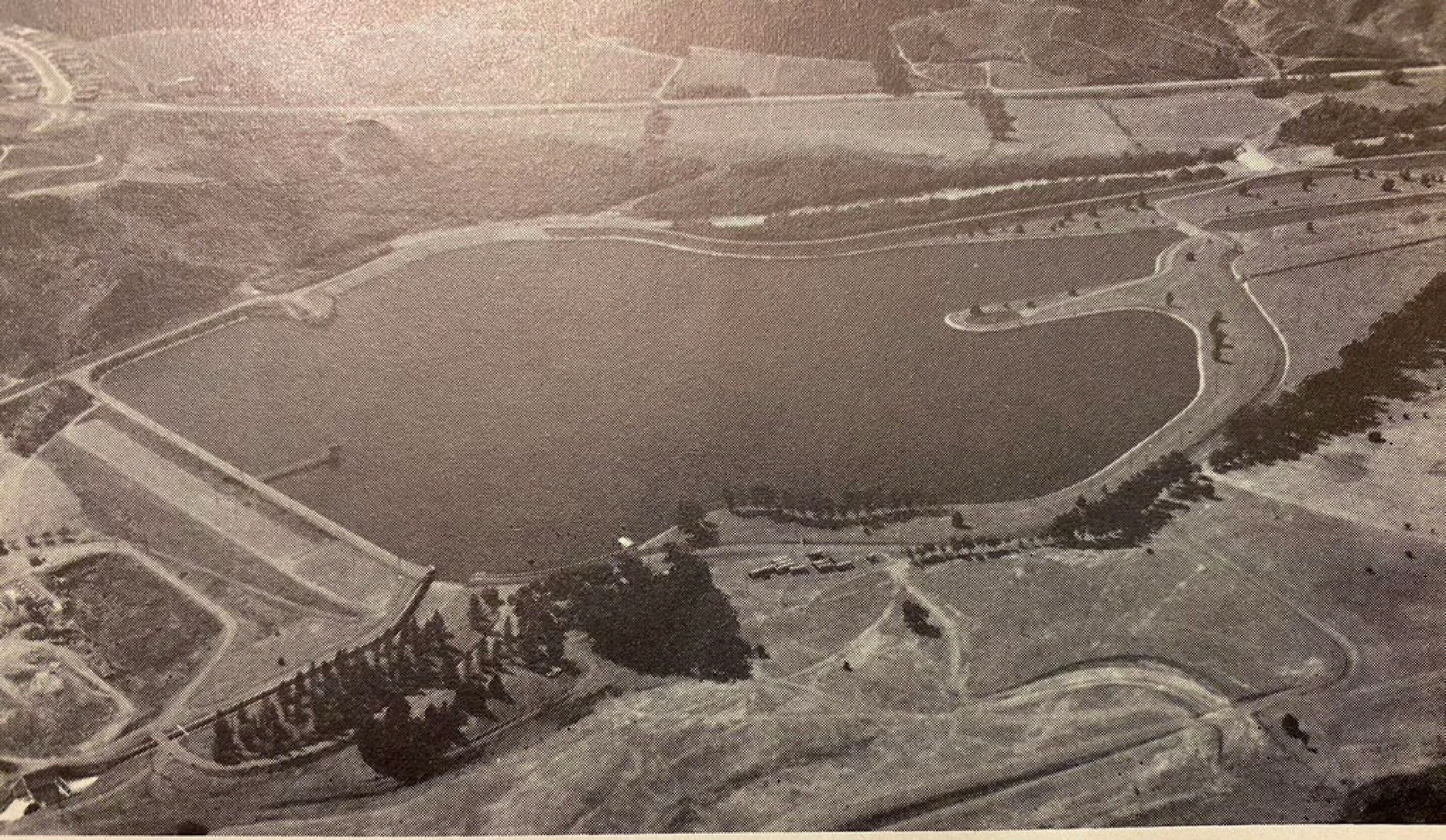
★



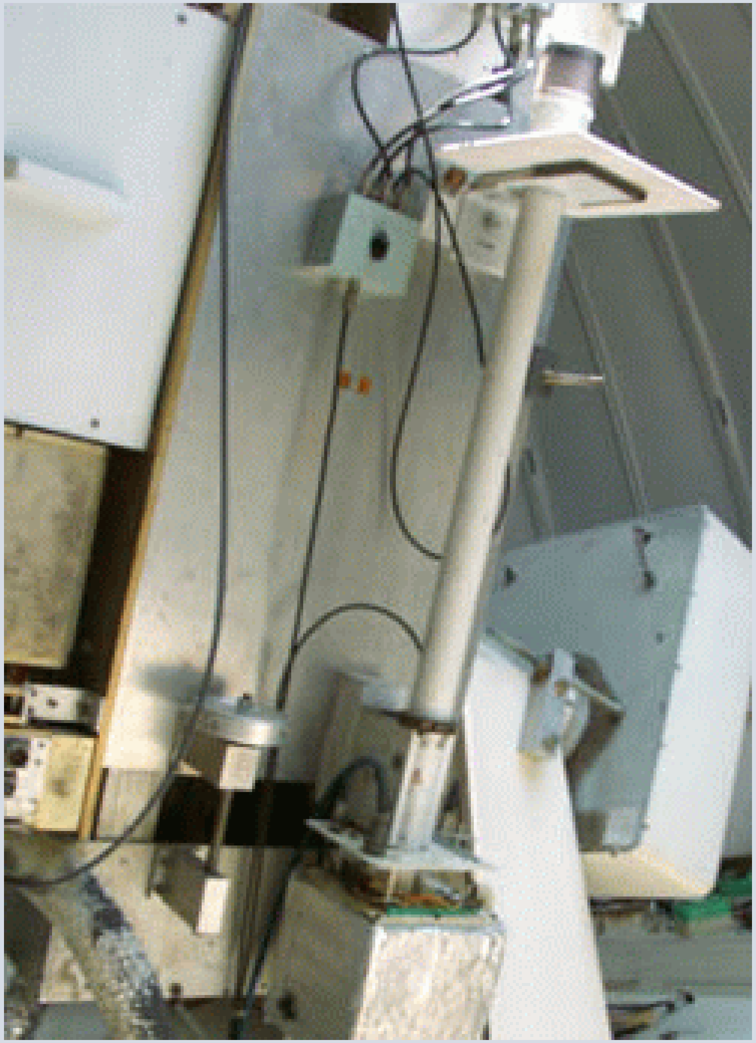
To the right of center in this aerial photograph of September, 1964, is the undeveloped peninsula on which San Fernando Observatory is now located. The view is toward the northwest, across Upper Van Norman Lake to Balboa Boulevard. Much recent construction has taken place nearby. Unless otherwise credited, all illustrations with this article are from Aerospace Corp.

Lower Van Norman Dam: earthquake damage to this earth-fill dam posed a major flood threat. Photo credit: Los Angeles Times. Source: CALIFORNIA GEOLOGY magazine, April-May 1971.


Granada Hills Youth Recreation Center
Upper Van Norman Lake
Sepulveda Blvd
N Sepulveda Blvd
Golden State Rd
Woodley Ave
Nanette St
5
161B
159

Golden State Fwy
Foothill Blvd
San Fernando Rd
5
161A
Foothill Blvd
210
Stetson Ranch Park
Foothill Fwy
210
Foothill Blvd
Foothill Blvd
Roxford St
Glenoaks Blvd
Borden Ave
San Fernando Rd
A
5
161B
Herrick Ave
Balboa Blvd
Granada Hills Youth Recreation Center
Bee Canyon Park
Van Gogh Street Elementary School
Upper Van Norman Lake
Roxford St
San Fernando Rd
Bradley Ave
Telfair Park
Sylmar
159
5
159B
159A
158
Polk St
San Fernando Rd
Balboa Blvd
Woodley Ave
Granada Hills North

Solar patrol photographic telescopes: white light continuum and H-alpha



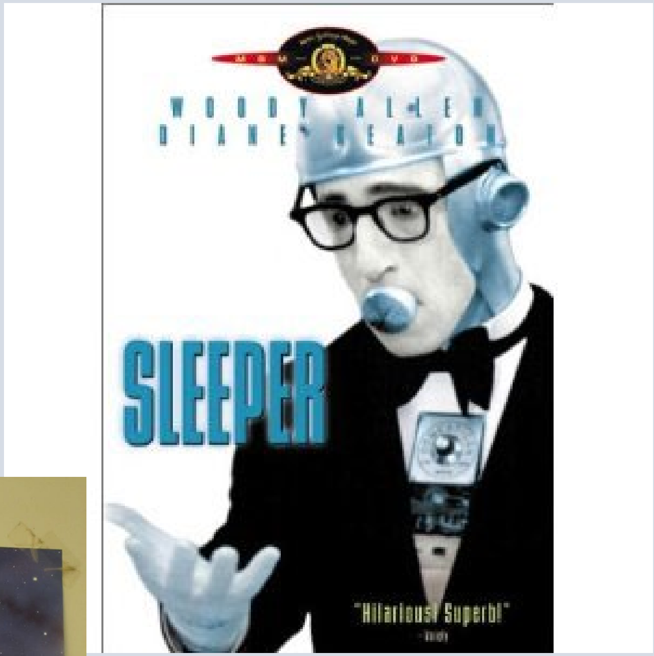
Cartesian Full Disk Telescope 1 (CFDT1)

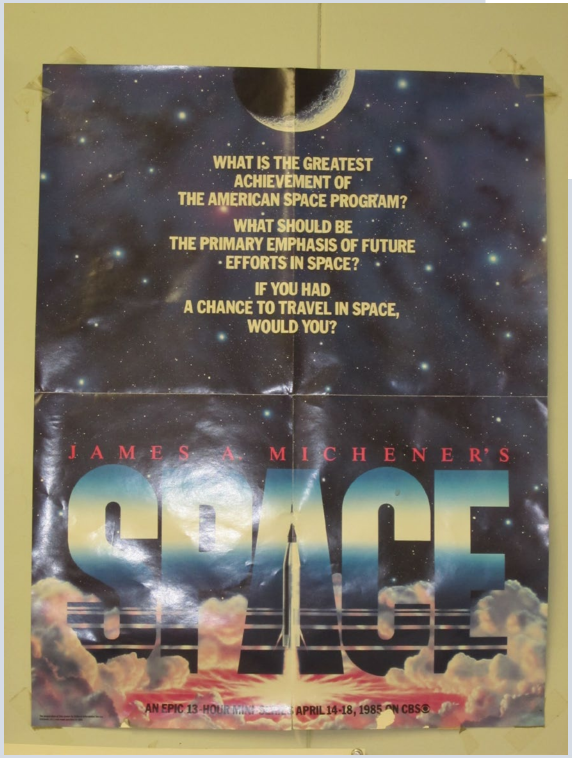
Cartesian Full Disk Telescope 2 (CFDT2)

SFO after repairs following the Northridge Earthquake


CSUN
Gary


STEPHEN MACHT AVERY SCHREIBER AND INTRODUCING DOROTHY R. STRATTEN AS GALAXINA
GALAXINA
IN THE 31ST CENTURY MAN FINALLY CREATED A MACHINE ...WITH FEELINGS!


WOODY ALLEN
DIANE KEATON
SLEEPER
"Hilarious! Superb!"


WHAT IS THE GREATEST ACHIEVEMENT OF THE AMERICAN SPACE PROGRAM?
WHAT SHOULD BE THE PRIMARY EMPHASIS OF FUTURE EFFORTS IN SPACE?
IF YOU HAD A CHANCE TO TRAVEL IN SPACE, WOULD YOU?
JAMES A. MICHENER'S
SPACE

What we do and how we do it…

- Ground-based, full-disk photometric images of the sun in several different wavelengths.

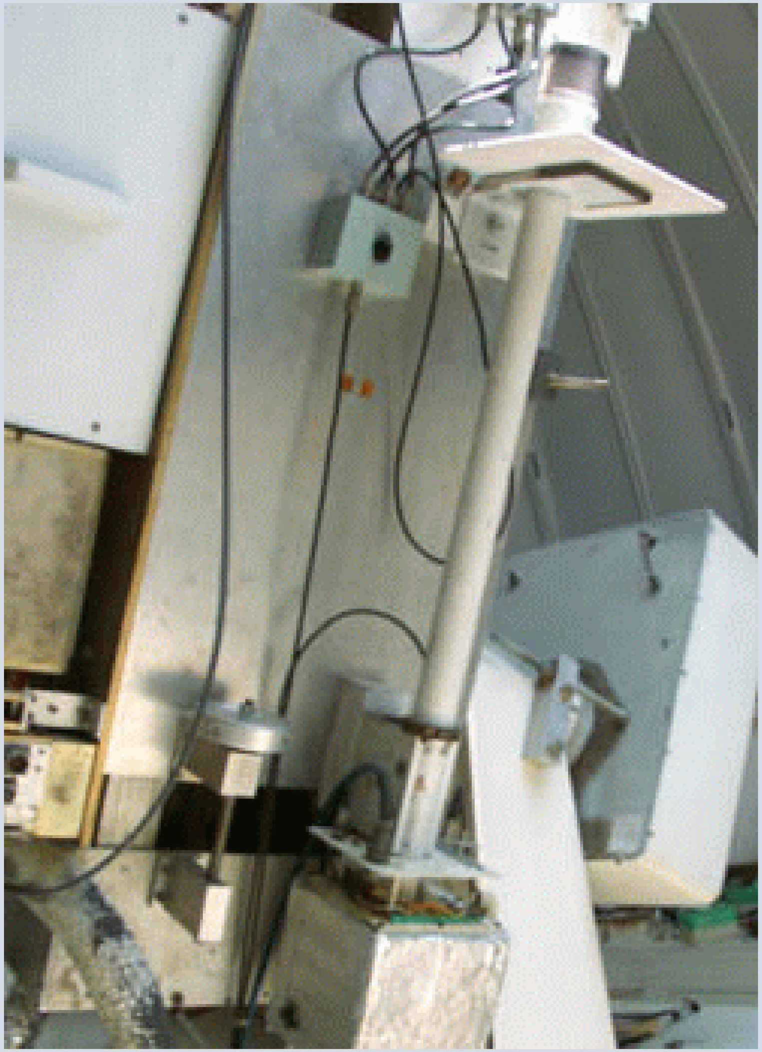
- Two telescopes, CFDT1 and CFDT2, differing mainly in size.

- Like climate records, long-term solar records are an important tool to help us understand how the sun works, especially how active-region surface features contribute to changes in solar irradiance.

- SFO ~38-year archive of full-disk images from which we extract surface feature information and calculate solar irradiance variations.

CFDT1: The first photometric telescope

- Online in May 1986
- 512 x 512 pixel images, 5 arc-sec resolution.
- 3 wavelengths: 672.3nm (red),472.3nm (blue) and 393.4nm (Ca II K-line).
- 40” focal length, 2 ¼ in lens stopped down to 1 in.
- Sensor is a Reticon 512 linear array.



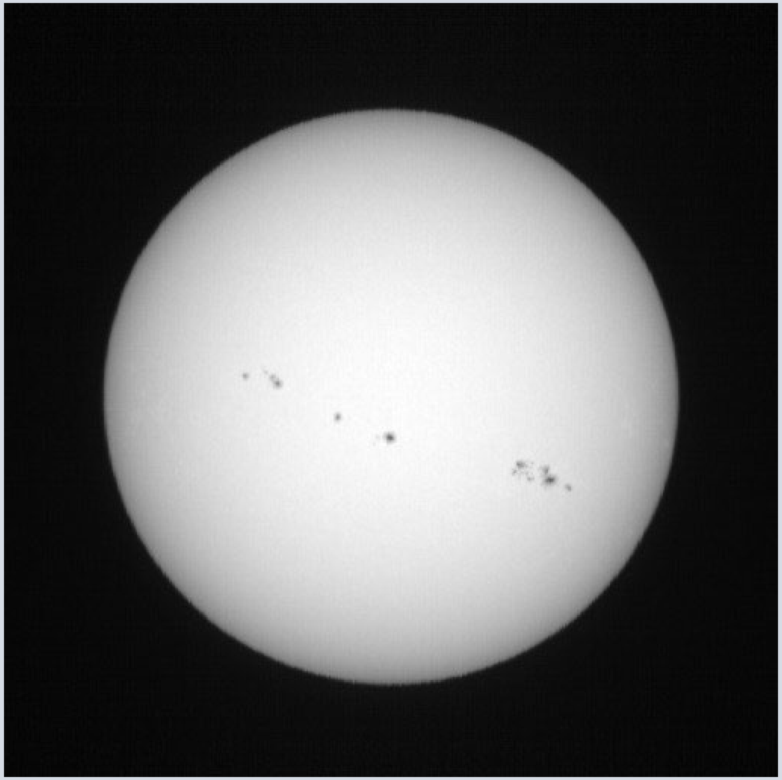
CFDT1

Light passes through the lens, down the tube, through a filter wheel, to sensor housed in the electronics box.

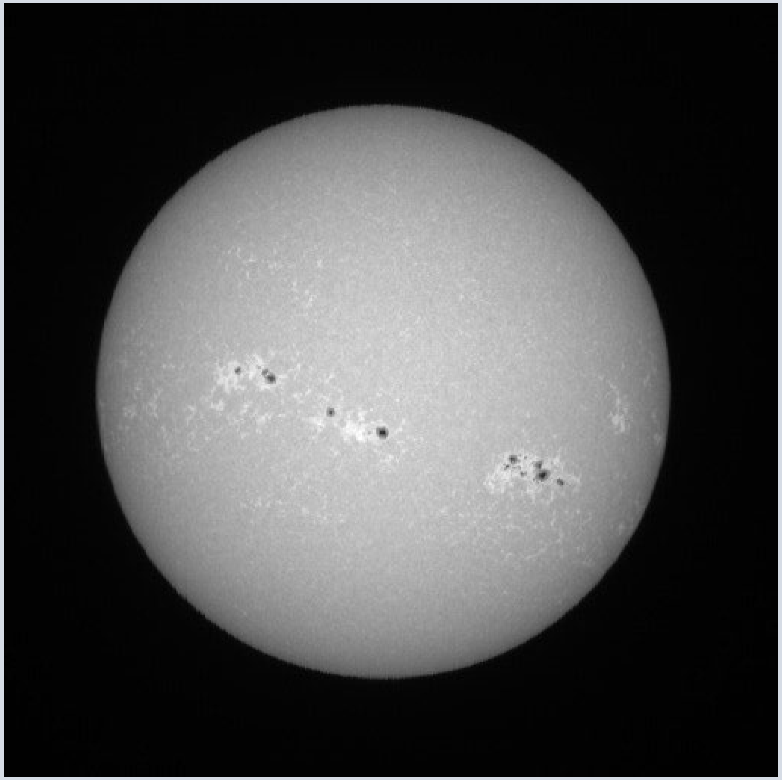
Sensor is a Reticon 512-linear diode array.

CFDT1 images

672.3nm (red)   Feb 14, 2014



393.4nm (Ca II K)   Feb 14, 2014



CFDT2: The second photometric telescope

- Online in 1992
- 1024 x 1024 pixel images, 2.5 arc-sec resolution.
- 3 wavelengths: 672.3nm (red),472.3nm (blue) and two Ca II K-line filters, narrow and wide K, differing only in the bandpass (393.4nm: narrow K-line has 0.3nm bandpass, wide K-line is 1.0nm), near IR (780nm), and IR (997nm).
- 38” focal length, 3 1/8” lens stopped down to 2 in.
- Position of filter wheel can be slightly adjusted for sharper focusing.
- Sensor is a Reticon 1024 linear array.

CFDT2

Basically, the same arrangement as CFDT1 only bigger sensor.

Light passes through the lens, down the tube, through a filter wheel, to sensor housed in the electronics box.

Sensor is a Reticon 1024-linear diode array.

Image calibration and processing:

- Calibrate the raw image using a same-day dark image and an automatically generated flat-field made from a tcal (bright image).
- Deghost removes faint internal reflection that sometimes appear in the images.
- Limbfit fits a limb to a full-disk image.
- Destripe removes vertical artifacts from the image (these are usually dust particles).
- Facelift removes any remaining artifacts.
- Addwcs adds a World Coordinate System to the image.
- Flatten produces a contrast image (flattened image) from which photometric features can be identified.
- Coadd used for Ca II K-line images only. Two images are taken 7 ½ minutes apart (start to start) and coadded to reduce noise.
- Walton,S.R., Chapman, G.A., Cookson, A.M., Dobias, J.J., Preminger, D.G. *Processing Photometric Full-Disk Solar Images*. Solar Phys. 179: 31-42, 1998.

Determining solar features

- “Onetrigger” goes through the flattened image pixel by pixel, looking for changes in brightness as compared to the quiet sun.

- Use two different methods to quantify these changes: feature identification and photometric sum.

Two methods for constructing a two-component model

Feature identification uses a threshold method to identify contiguous pixels on a photometric contrast image that are either darker or brighter than the surrounding quiet Sun surface based on a pre-determined contrast criteria. Default contrast criteria for SFO images are -8.5% for sunspots and +4.8% for faculae.

This method identifies sunspots on red (672.3nm) images and faculae on Ca II K (393.4nm) images. We then identify and compute several different parameters, the most important of which, for irradiance variability studies, are sunspot areas and deficits; and faculae areas, faculae excesses, and Ca II K excesses. Secondary indices, such as umbral areas, are computed for use in other projects.

Two methods for constructing a two-component model, continued:

- **Photometric sum (Σ)**, which does **not** rely on feature identification, has proven to be one of the most successful photometric indices produced (Preminger, Walton, & Chapman 2002, *JGR*, **107** 6). **Σ** measures the relative change in spectral irradiance in filter passband due to all features and assumes image noise is symmetric around zero, causing bright and dark noise pixels to cancel, leaving only contributions from real features.

- $\boldsymbol{\Sigma_r}$ and $\boldsymbol{\Sigma_K}$ are disk-integrated sums determined from red and Ca II K contrast-image pixels, respectively; each pixel is weighted by the appropriate limb-darkening. This method produces a single value for each image.

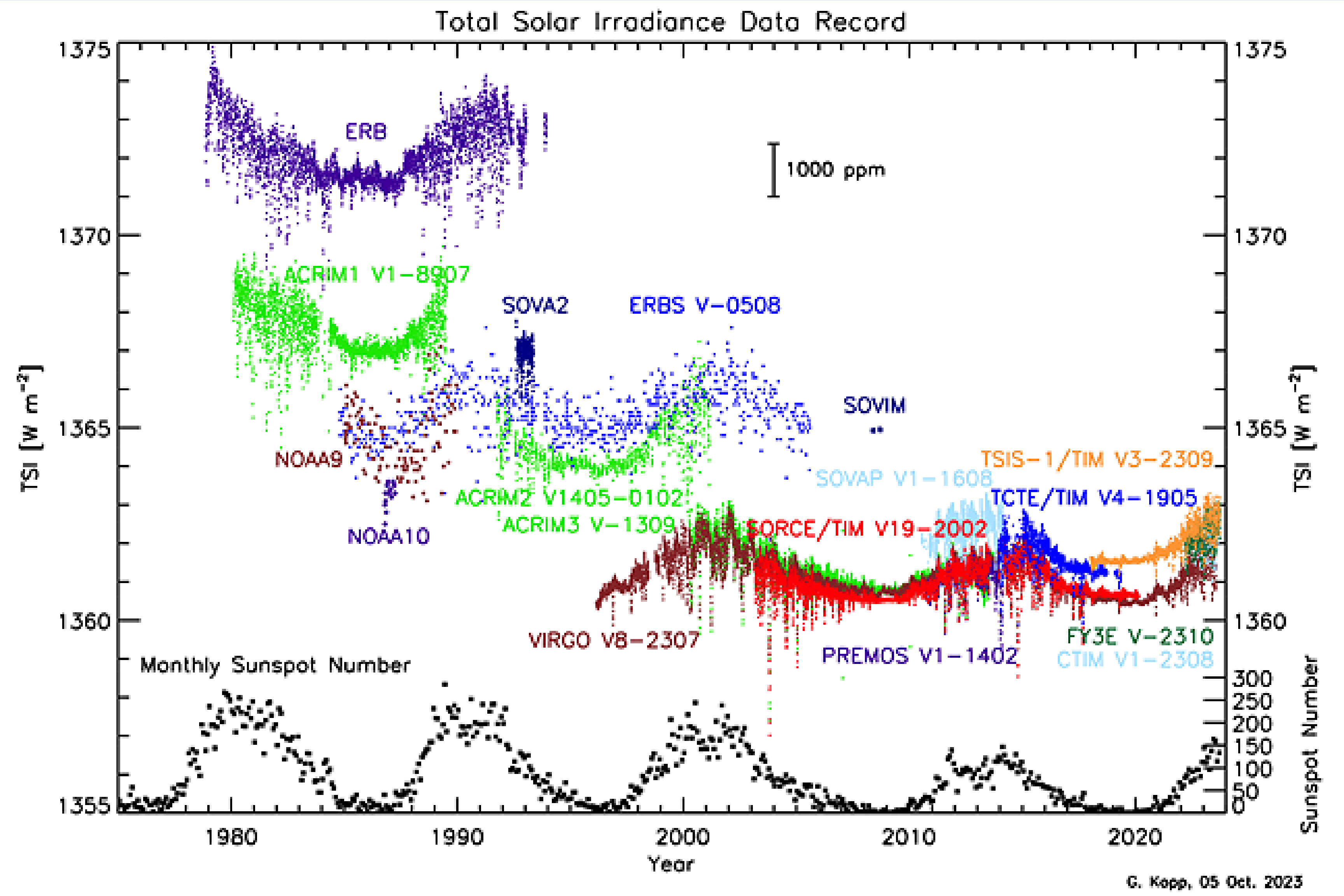
- $\boldsymbol{\Sigma_r}$ measures irradiance contributions from photospheric structures seen in red continuum images. $\boldsymbol{\Sigma_K}$ measures variability of the upper photosphere/lower chromosphere seen in Ca II K images.

Value in comparing images from different sources

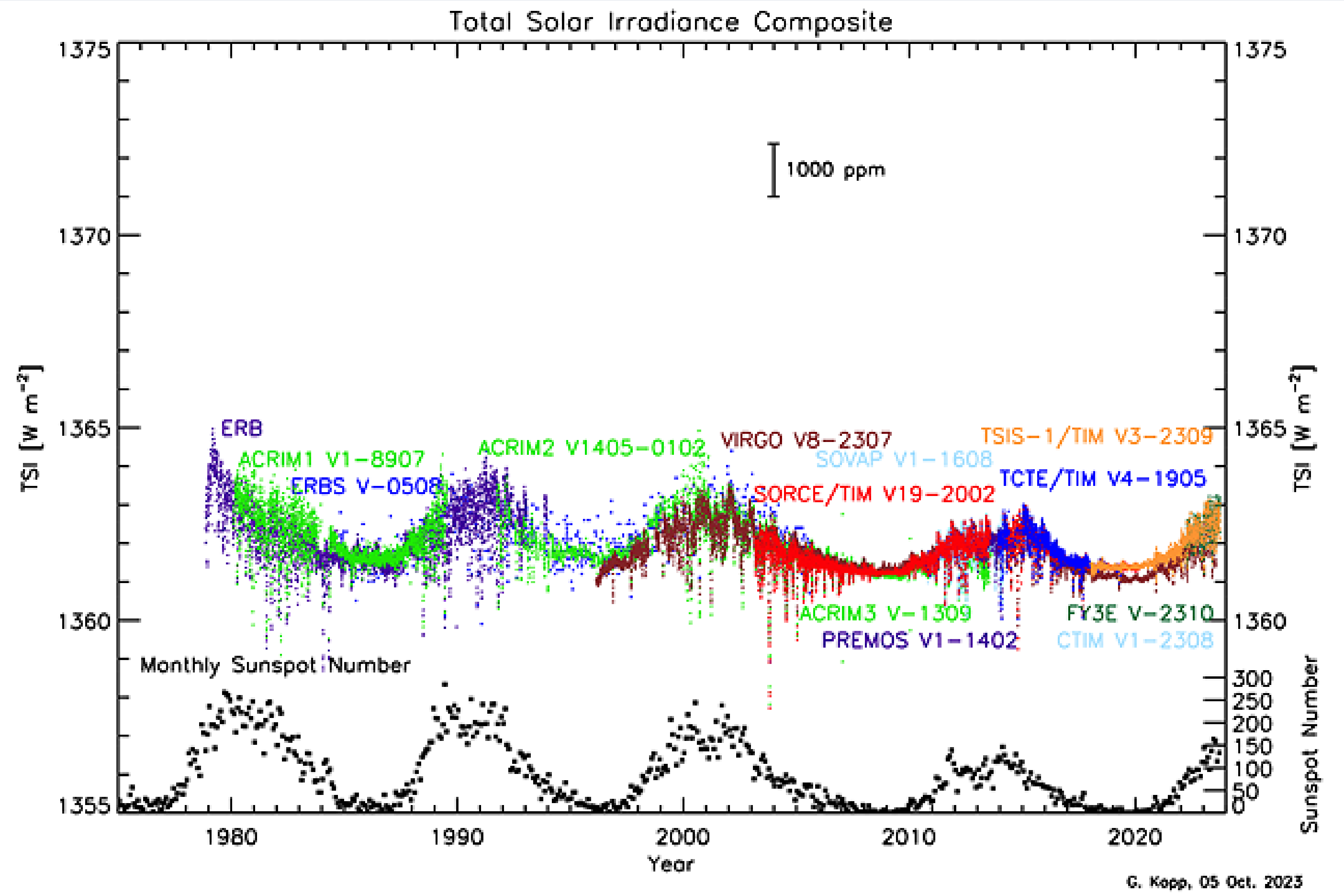
- Images from different instruments, different researchers, different algorithms.
- Comparisons help identify anomalies and discrepancies in a given dataset.
- E.g., significant differences in sunspot areas. Time of day and SFO "guard zone."

How is SFO data used?

- TSI is an important input to Earth's climate system but can only be measured from space.
- First space-borne instrument was Nimbus-7 in 1978, followed by a succession of satellite instruments, each more sophisticated and reliable than the previous.
- The data from these individual instruments have been carefully knitted together, through several reiterations, resulting in the current long-term TSI composite dataset.



Thank you , Greg!



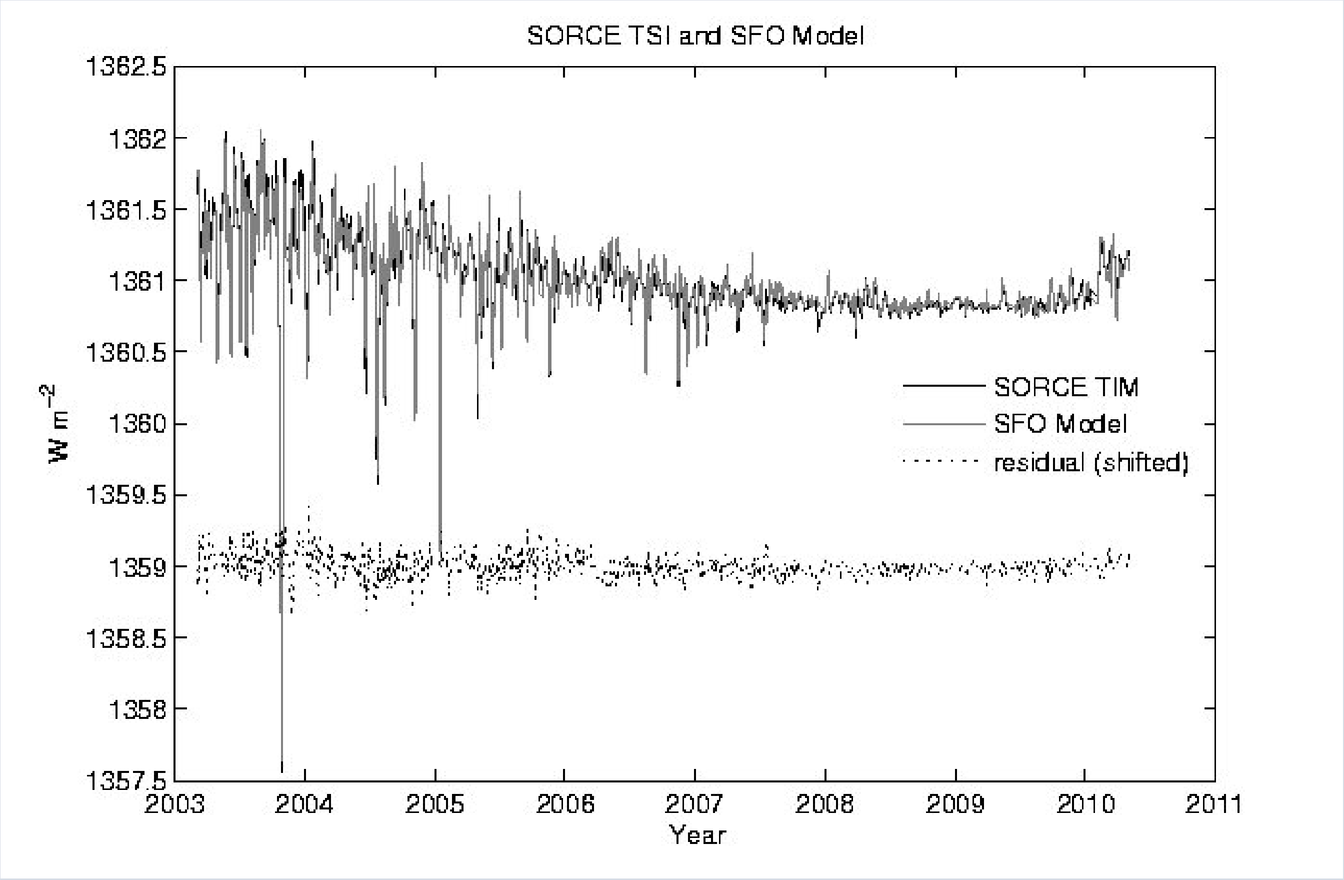
Thank you, again, Greg!

Two-component models

- Two-component models based on an index calculated from the continuum measurement of sunspot area and deficit from SFO red images and an index calculated from facular area and excess from our Ca II K images.
- Faculae best measured in the Ca II K-line, the near UV, since the facular contrast becomes too small to be reliably detected in the visible continuum, especially towards disk center.
- Also, with regard to faculae, long-term TSI variations are associated with the faculae and plage rather than sunspots (Ermolli, et al., 2003).
- And, the contribution of the near_UV irradiance variation is approximately 19% of TWI variability (Lean, et al 1989).
- Developing proxies, like our Ca II K, that capture variations found in the upper photosphere/low chromosphere, is important.

We regress sunspot and facular information, or Sigmas taken from red and K-line, against satellite Total Solar Irradiance or, in some cases, Spectral Solar Irradiance to see how these components can explain the variation in irradiance.

Previous work has shown that a combination of SFO Σ_r and Σ_K closely correlates to SORCE TSI with R^2=0.95. The Σ indices sum all dark and bright pixels across an image (red and Ca II K) to obtain a single value for that image, with no explicit feature identification. The remaining 0.05 can be attributed to noise, both instrumental and solar intensity.



Other uses for this data

- In the early days of TSI measurements, the results of these two-component linear regressions helped fill gaps in the TSI record between satellites, as well as identifying instrument anomalies.
- But satellites are a lot more robust and reliable now since SORCE and its successors have been measuring TSI, but ground-based images still have their place.

- Should a giant CME wipe out the latest space-based instruments, the San Fernando Observatory will be waiting in the wings to help fill the gaps.

- And, of course, we continue to supply solar indices and images to both the irradiance and climate communities.