About one-order of magnitude **smaller, but still challenging and breakthrough:** the case for **solar telescopes**

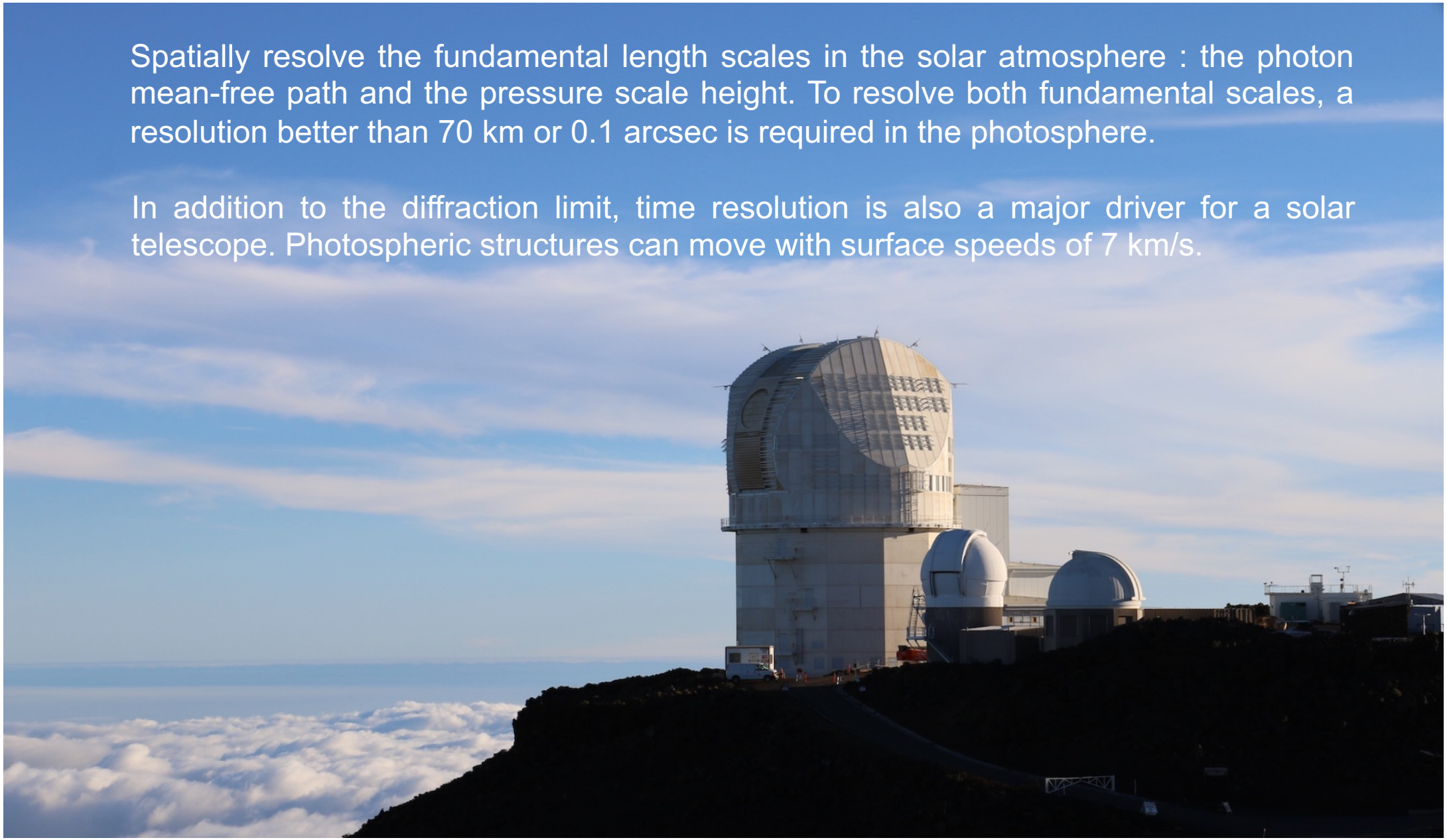
Ilaria Ermolli

INAF Osservatorio Astronomico di Roma

Chianti Topics VI – 27/02/2024

Spatially resolve the fundamental length scales in the solar atmosphere : the photon mean-free path and the pressure scale height. To resolve both fundamental scales, a resolution better than 70 km or 0.1 arcsec is required in the photosphere.

In addition to the diffraction limit, time resolution is also a major driver for a solar telescope. Photospheric structures can move with surface speeds of 7 km/s.



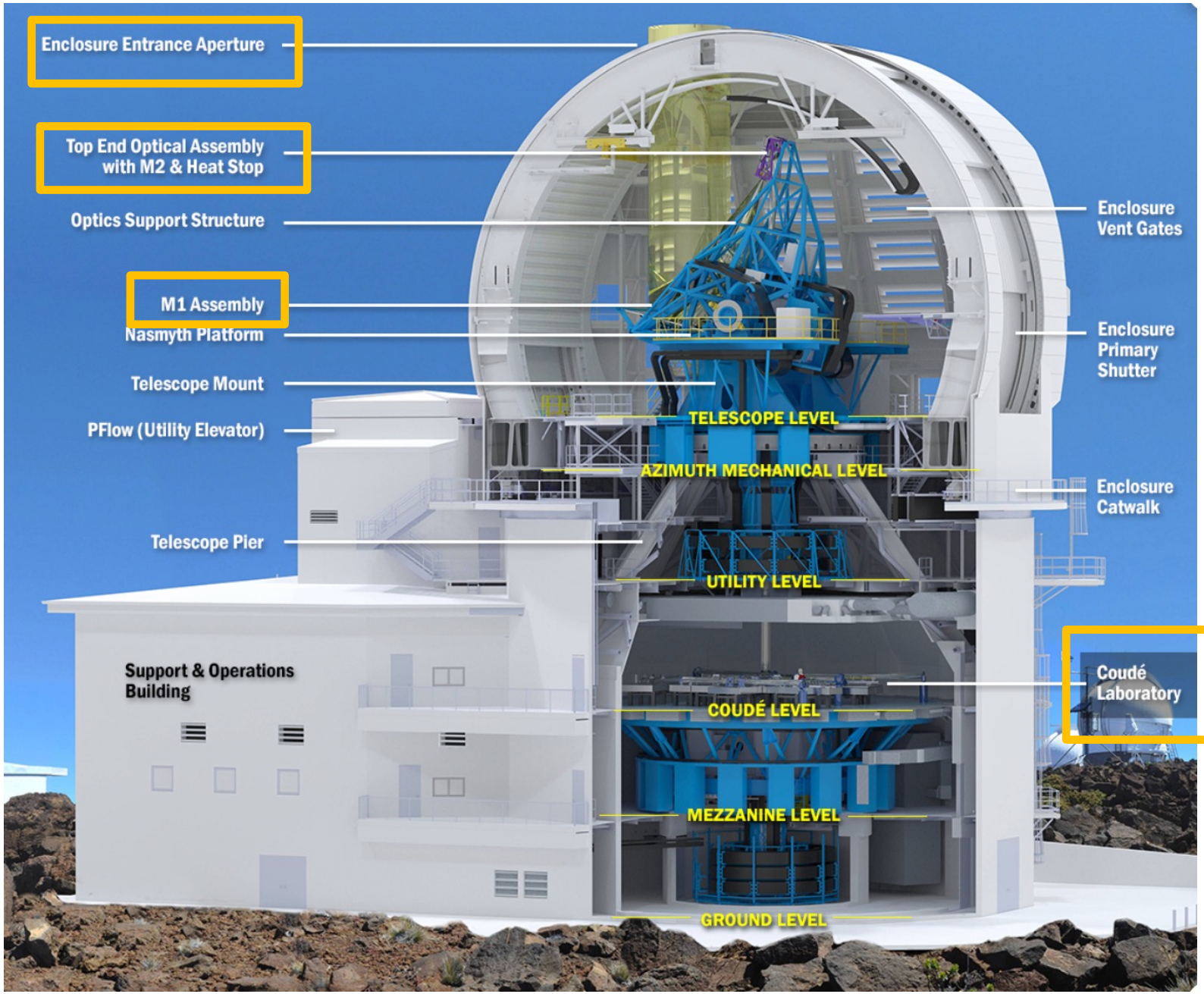
DKIST Daniel K. Inouye Solar Telescope, Haleakala, Maui, HW

Credits: NSO/AURA/NSF, USA

Credits: NSO/AURA/NSF, USA

Passing only 5 arcmin circular FOV
Reduces heat load from 12000W to 300 W on subsequent optics.
Actively cooled with liquid
12 mm diameter

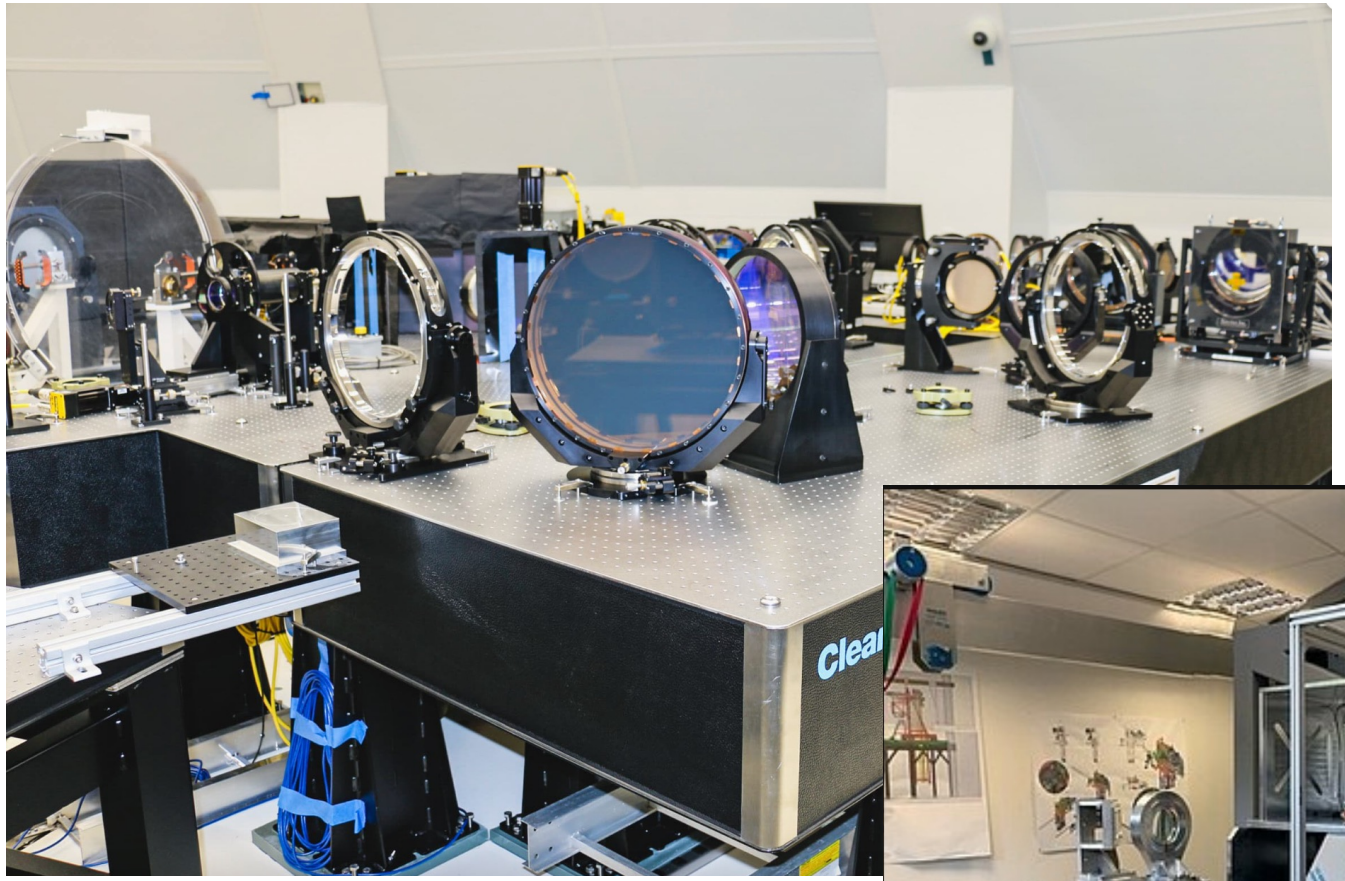
4m clear aperture
actively cooled from rear side with chilled air
Active shape control



Rotating platform
16.5m diameter
150-ton
First light facility Instruments and Wave-front correction system (WFC)

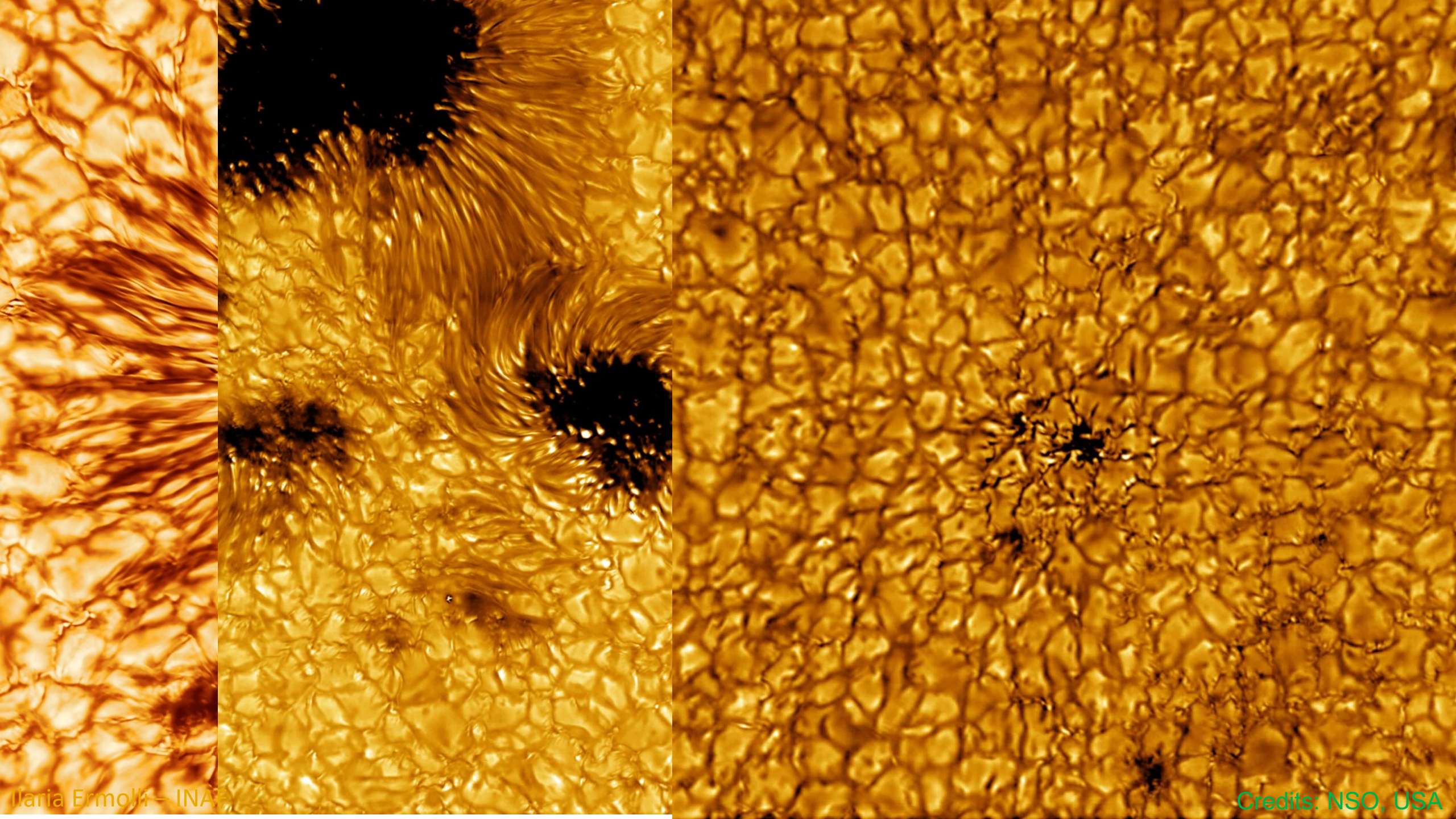
1600-actuator DM, a correlating Shack-Hartmann WFS, a fast tip-tilt mirror, and an FPGA-based control system. Running at a nominal rate of 1975 Hz.

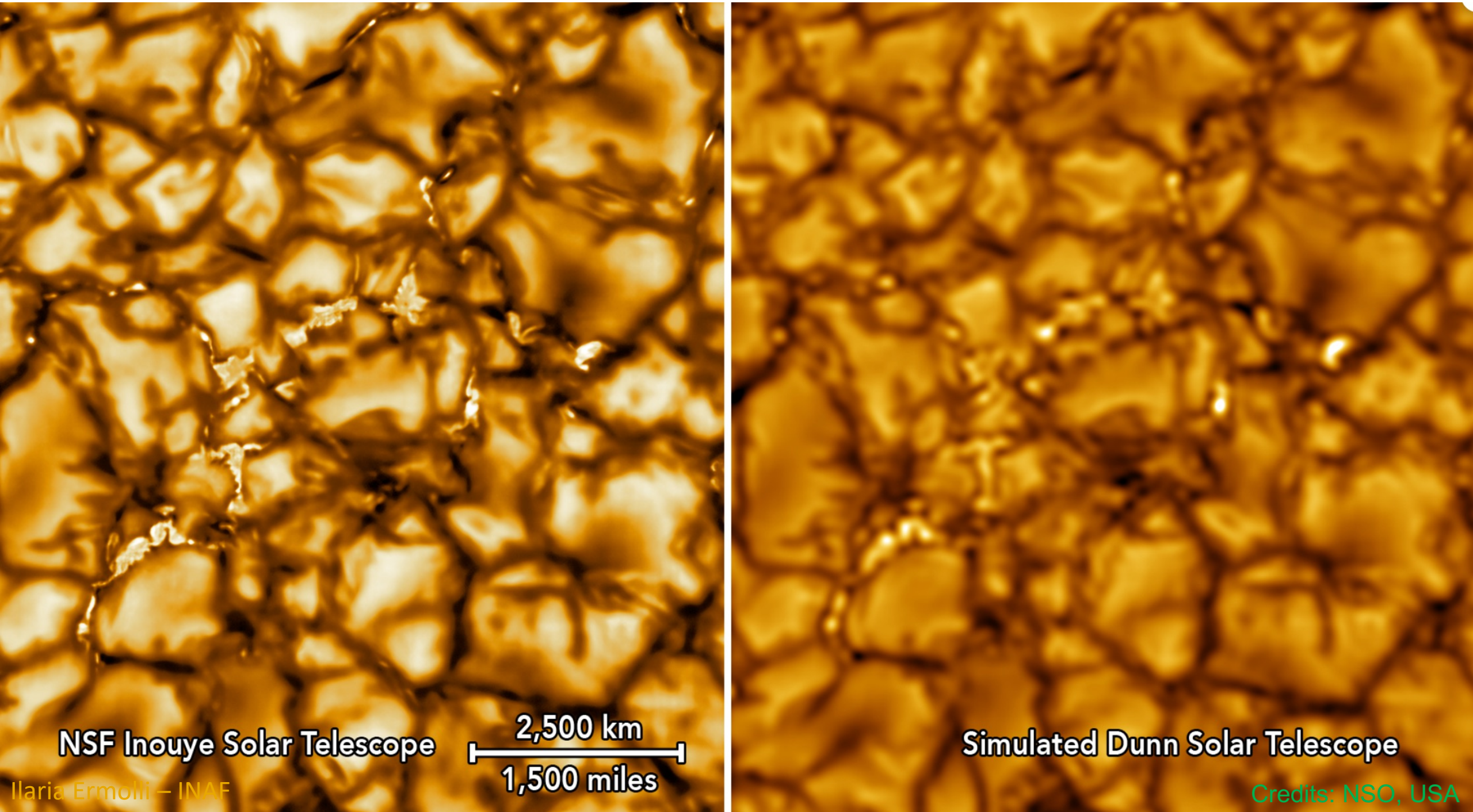
Credits: NSO, USA; KIS, D

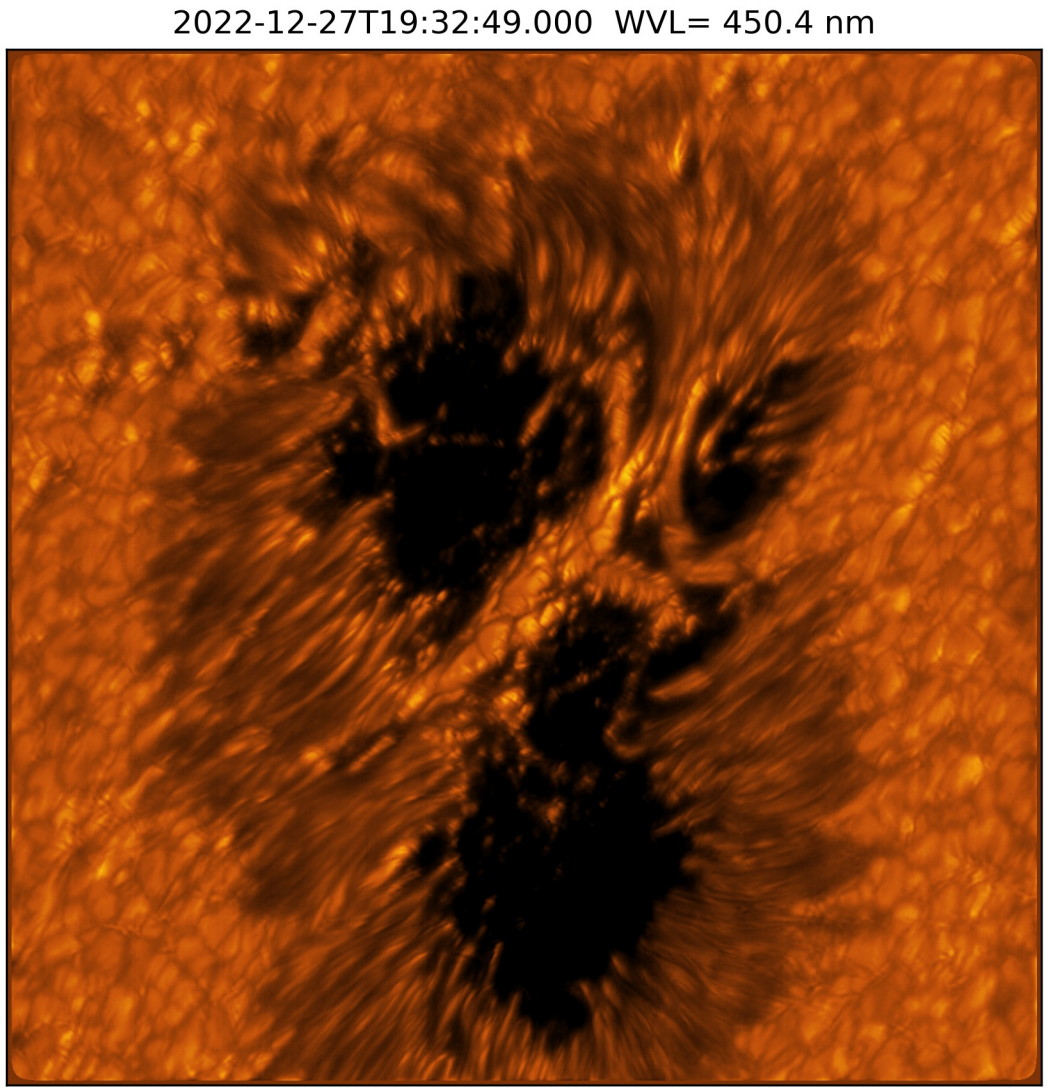


VBI Visible Briad Band Imager

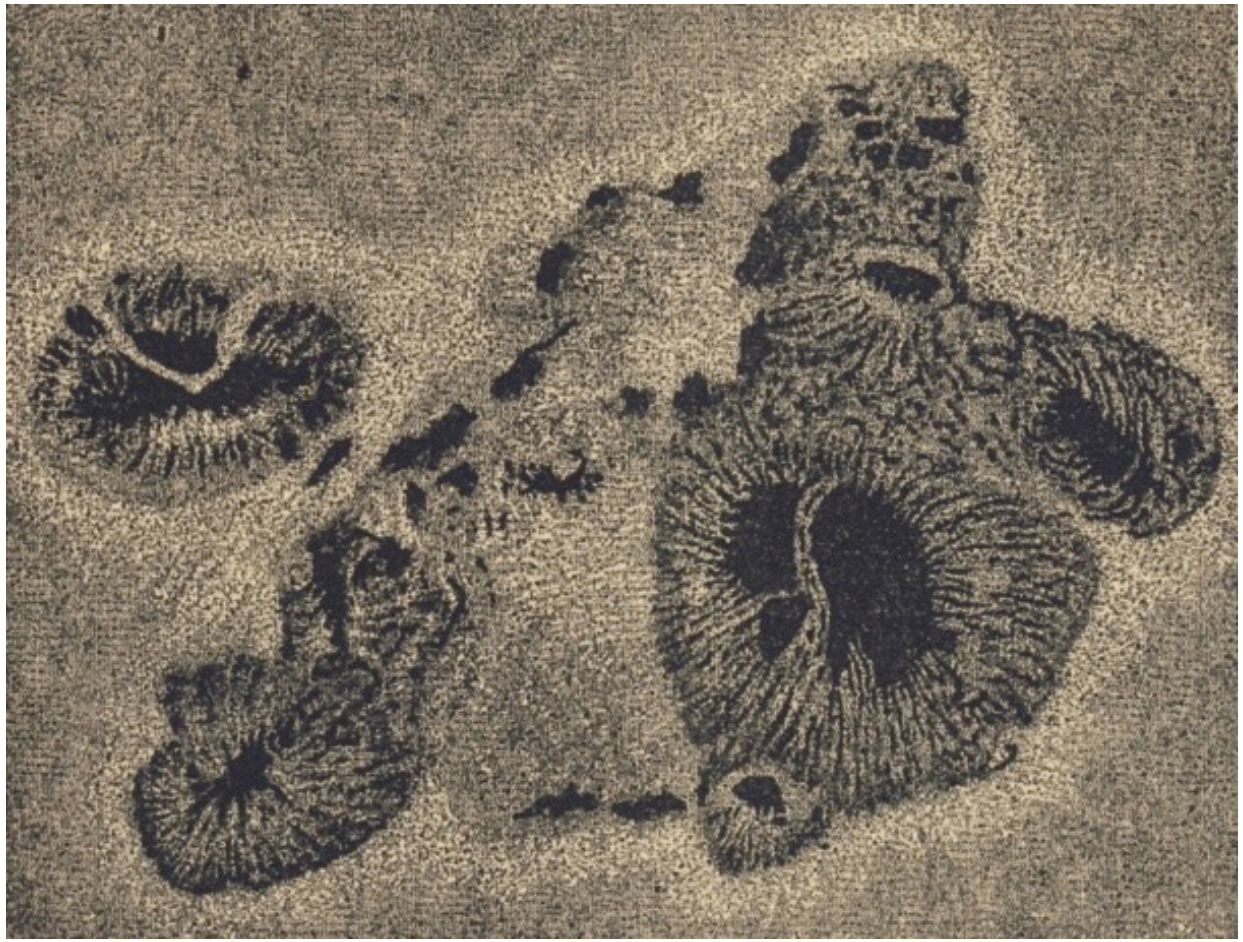
VTF Visile Tunable Filter @ KIS


Ilaria Ermolli – INAF
Credits: NSO, USA


NSF Inouye Solar Telescope
2,500 km
1,500 miles
Simulated Dunn Solar Telescope
Ilaria Ermolli – INAF
Credits: NSO, USA

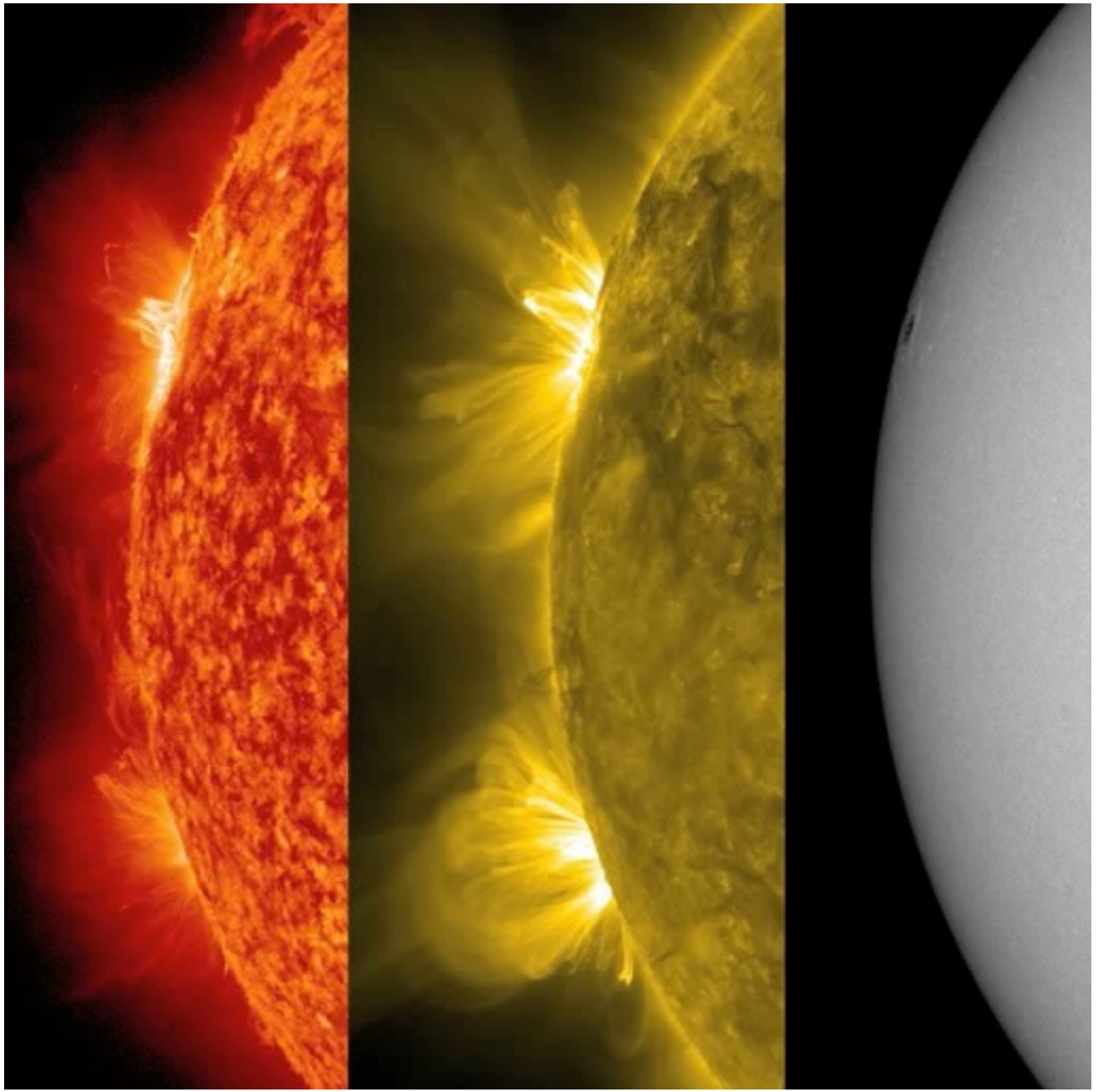


DKIST



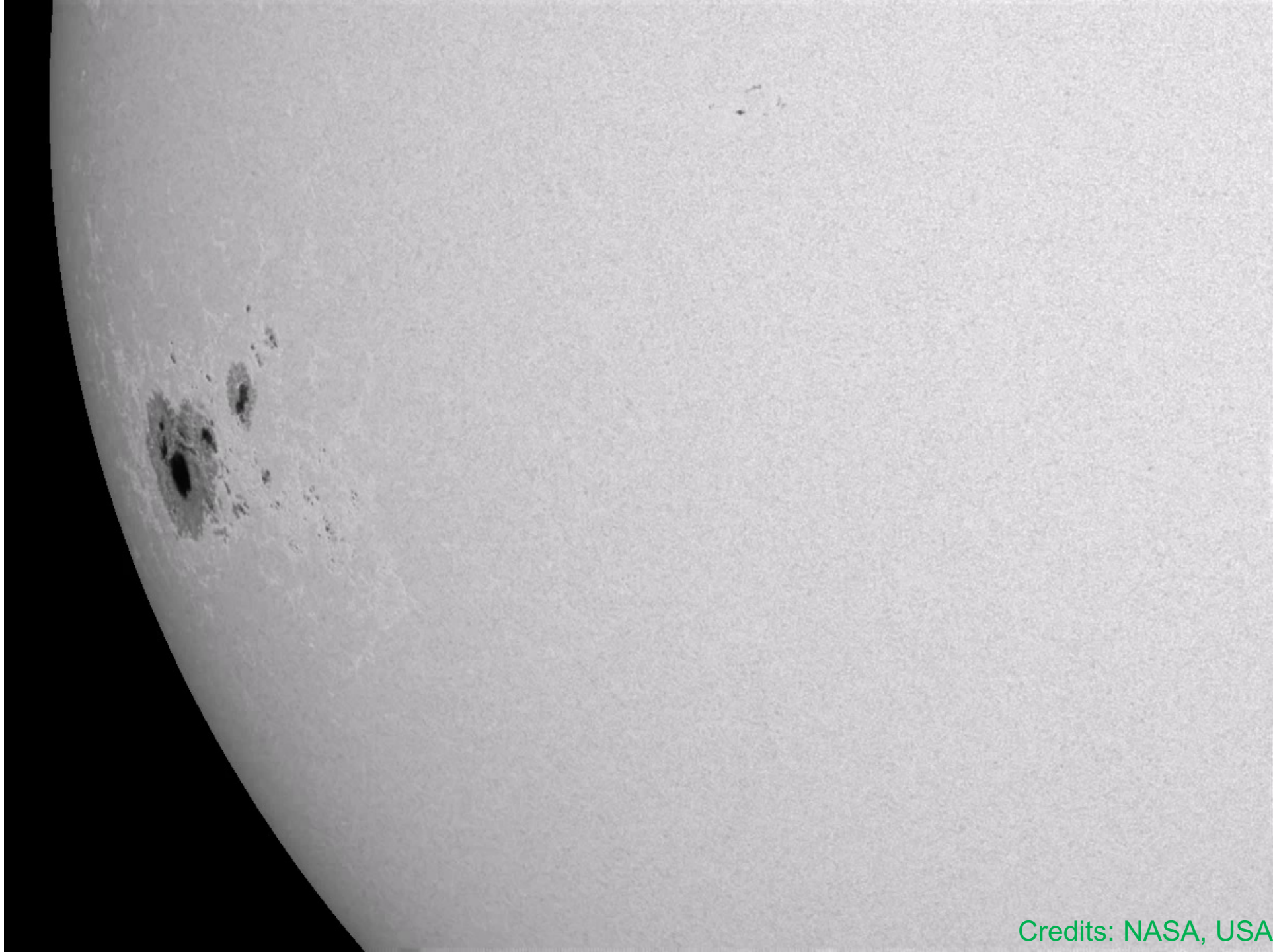
Angelo Secchi 1858

Study fundamental astrophysical processes at their fundamental length scales



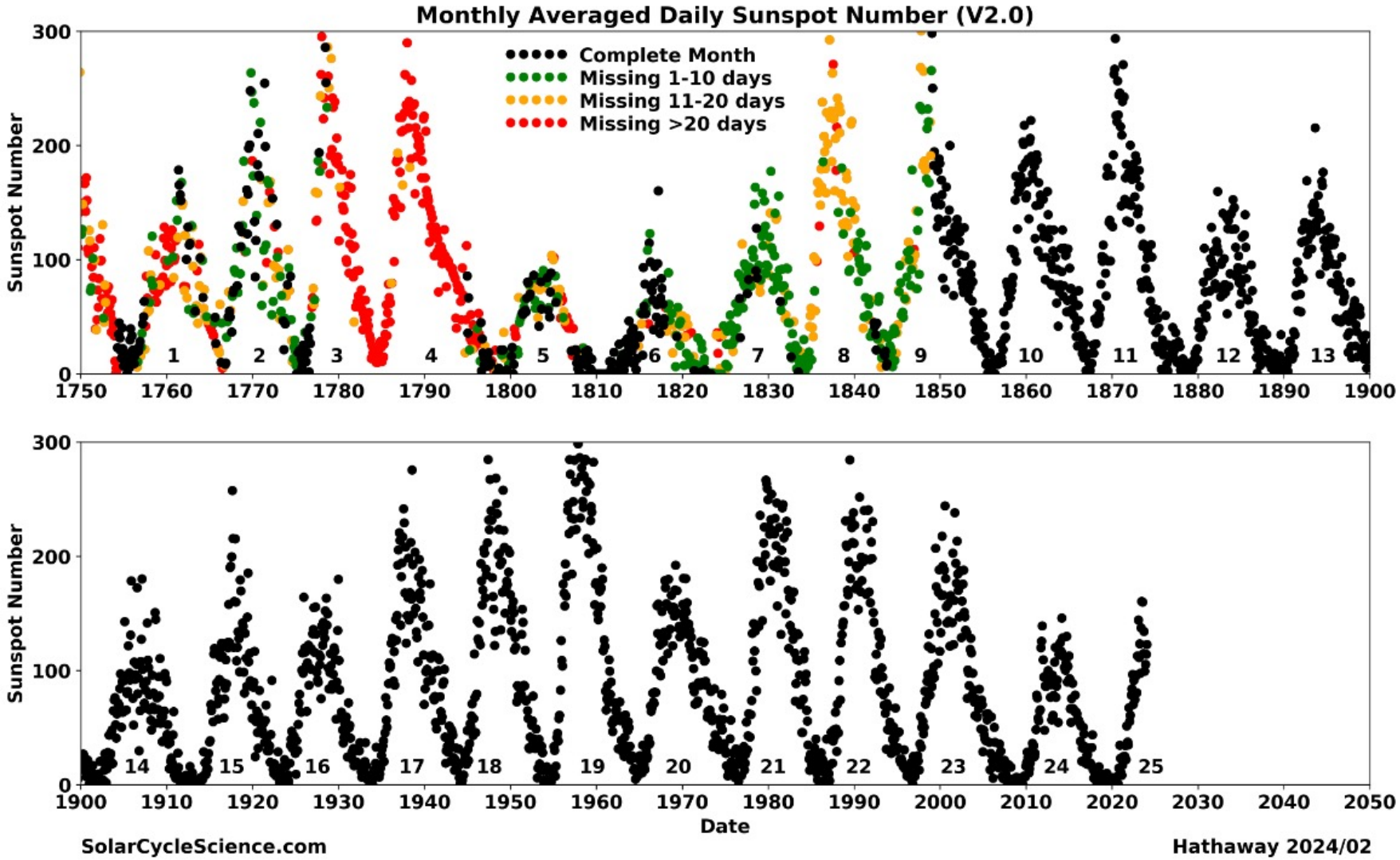
Credits: NASA, USA

Understand the **plasma-magnetic field interplay** driving the **evolution** of magnetic regions



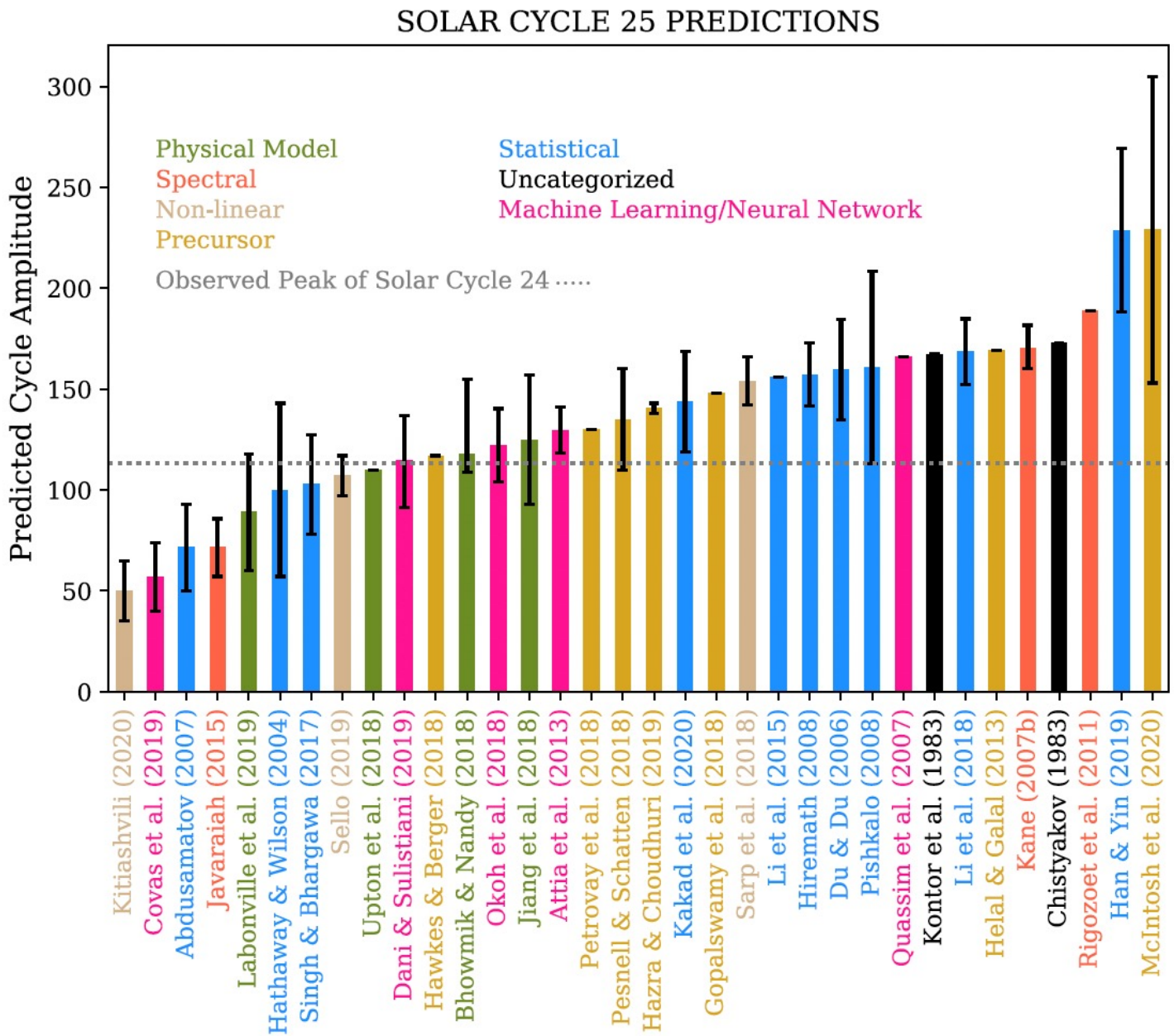
Credits: NASA, USA

Understand solar variability



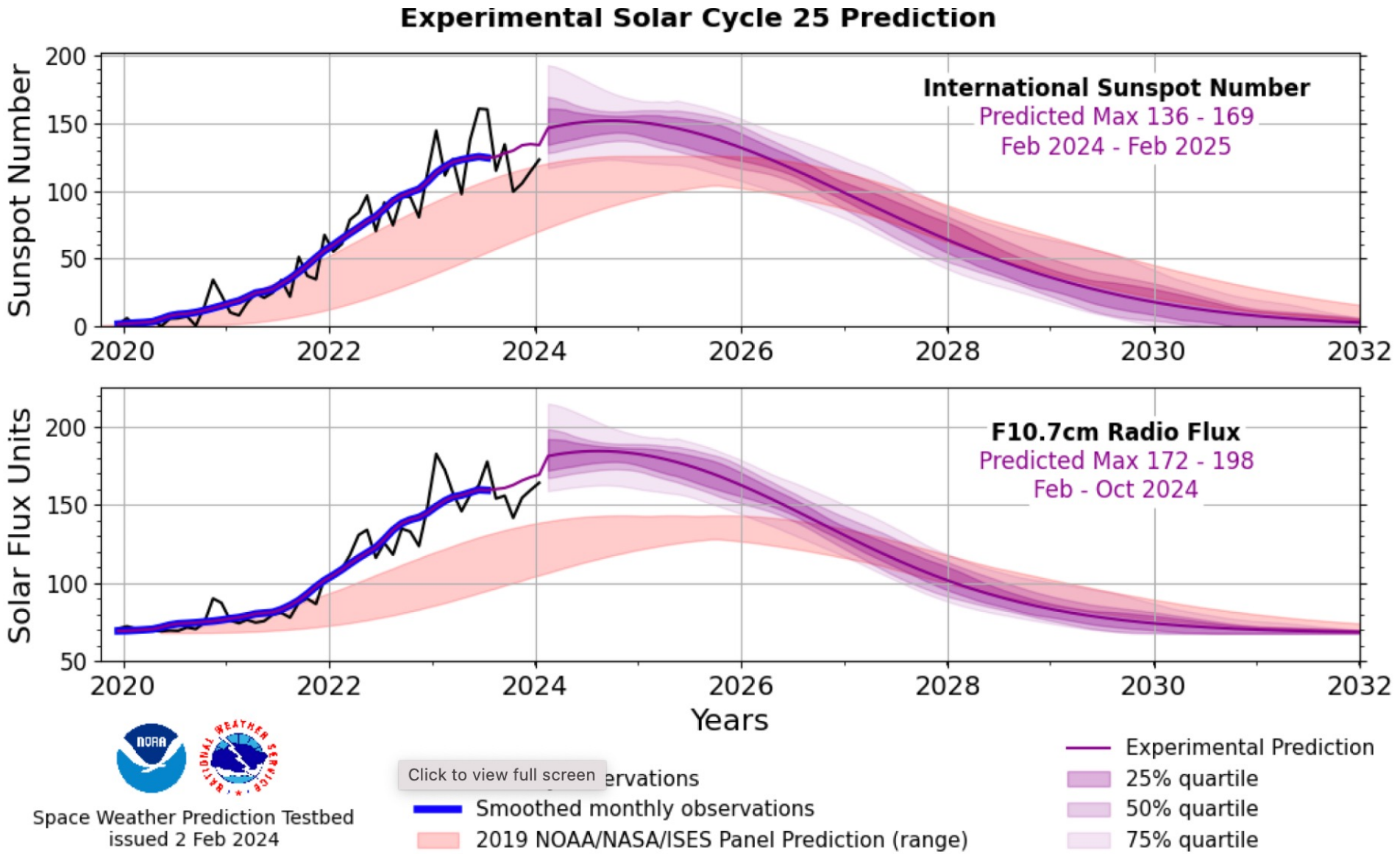
Credits: David Hathaway'Webpage, USA

Understand solar variability and **accurately predict its basic aspects**



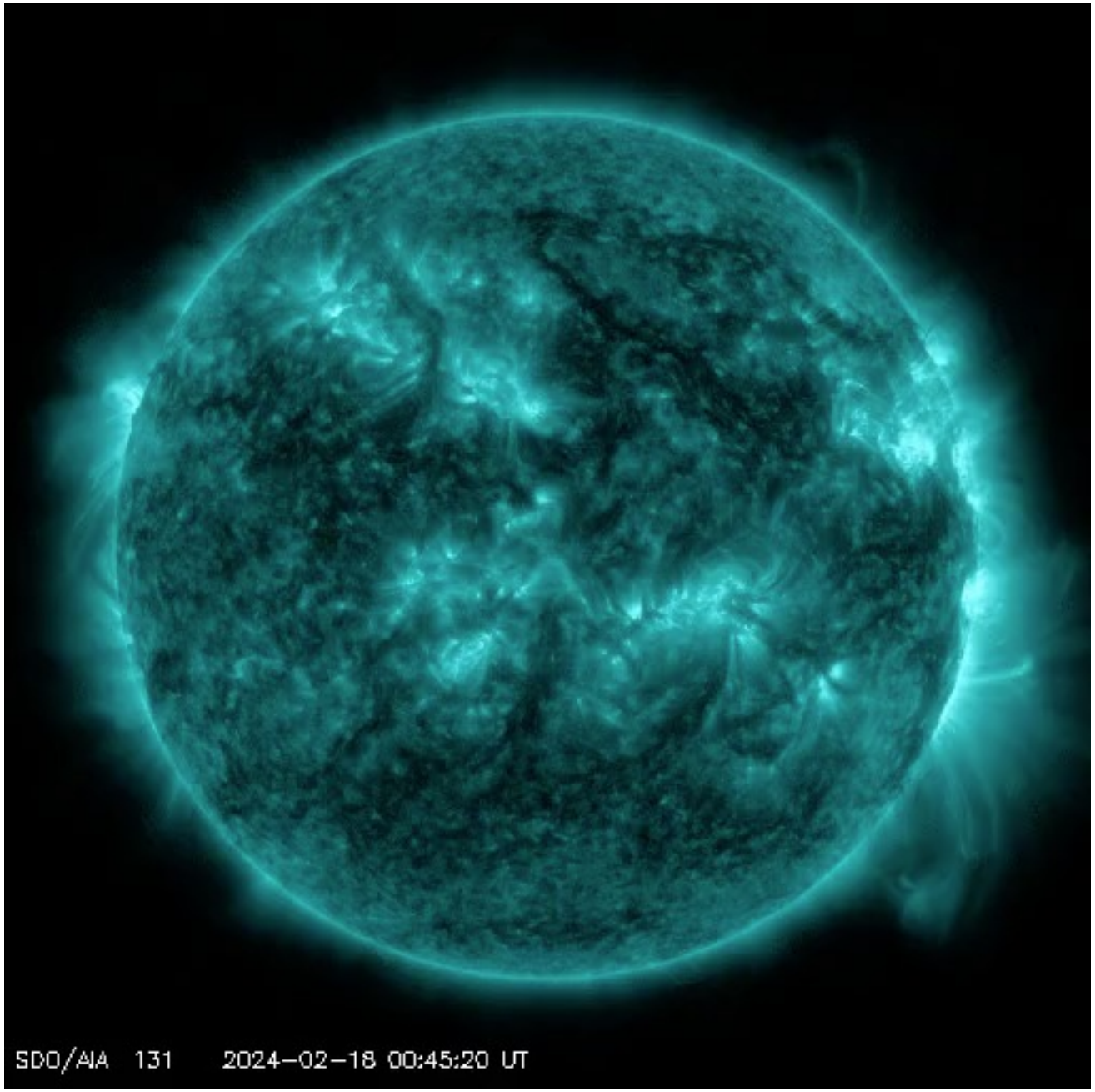
Nandy 2021, Solar Physics

Understand solar variability and **accurately predict its basic aspects**



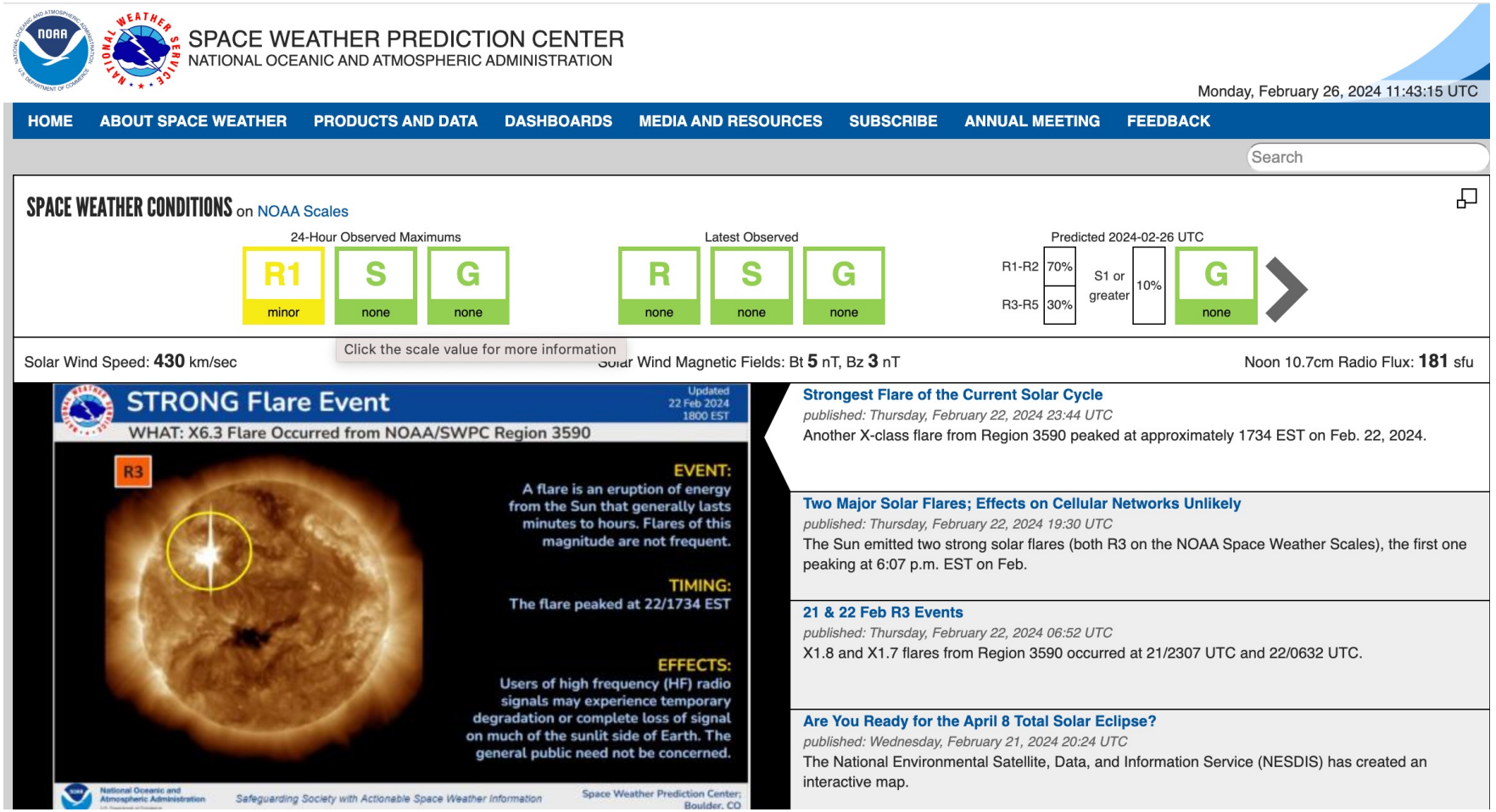
Credits: NOAA, USA

Predict disturbances of the space environment **induced by the Sun**



Credits: NASA, USA

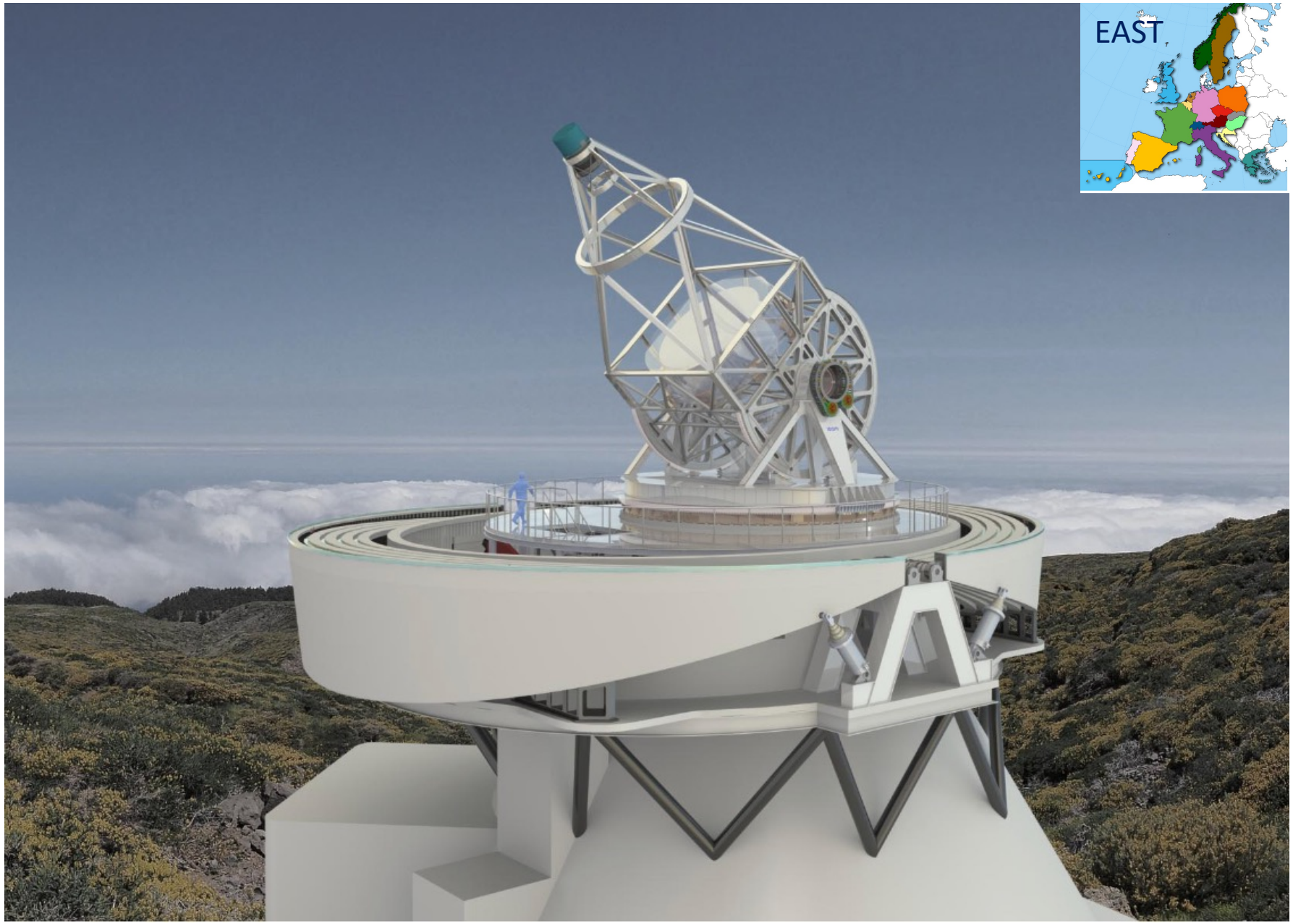
Predict disturbances of the space environment **induced by the Sun**



Credits: NOAA, USA

EST European Solar Telescope

Canarian Foundation



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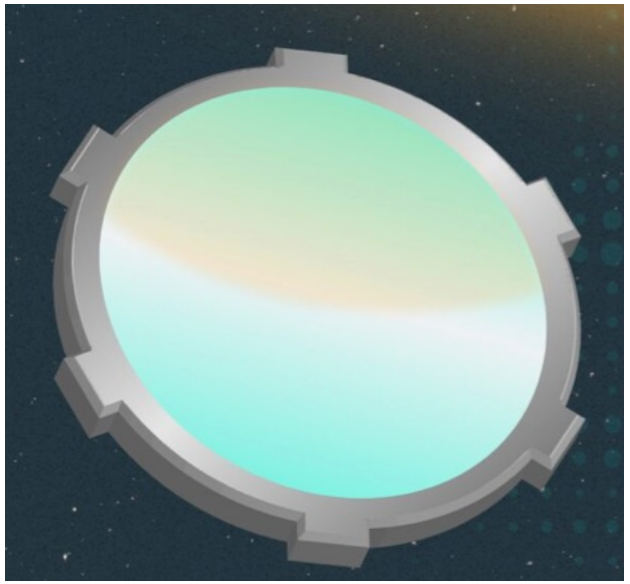
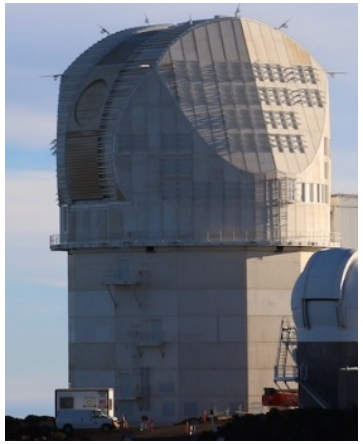
Credits: EST project

GIANT



DKIST/4m



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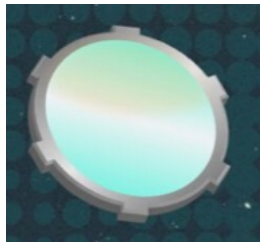
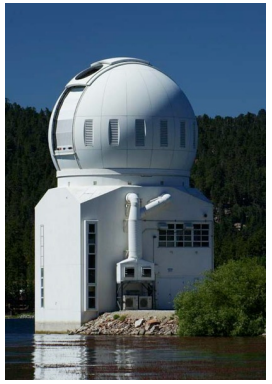


NGST/1.6m
GREGOR/1.5m

SST/1.m
THEMIS/0.9m

DST/0.7m
VTT/0.7m



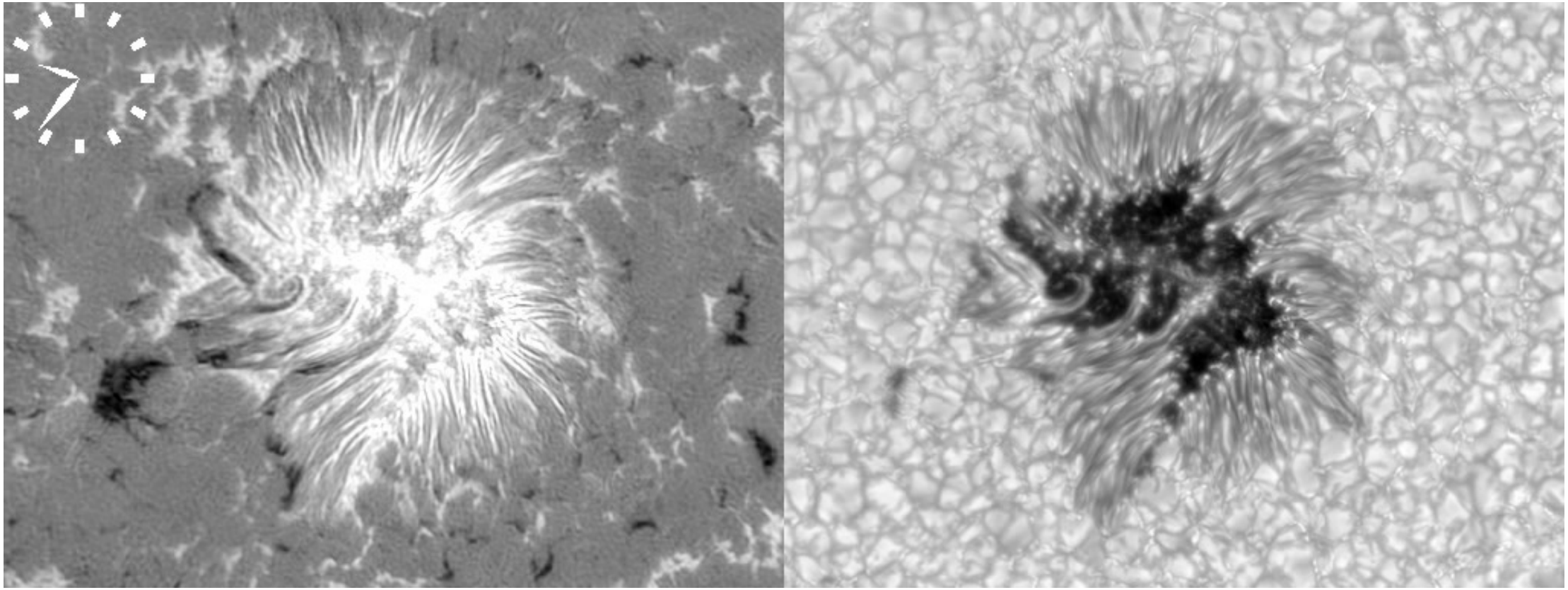

NGST


SST


THEMIS

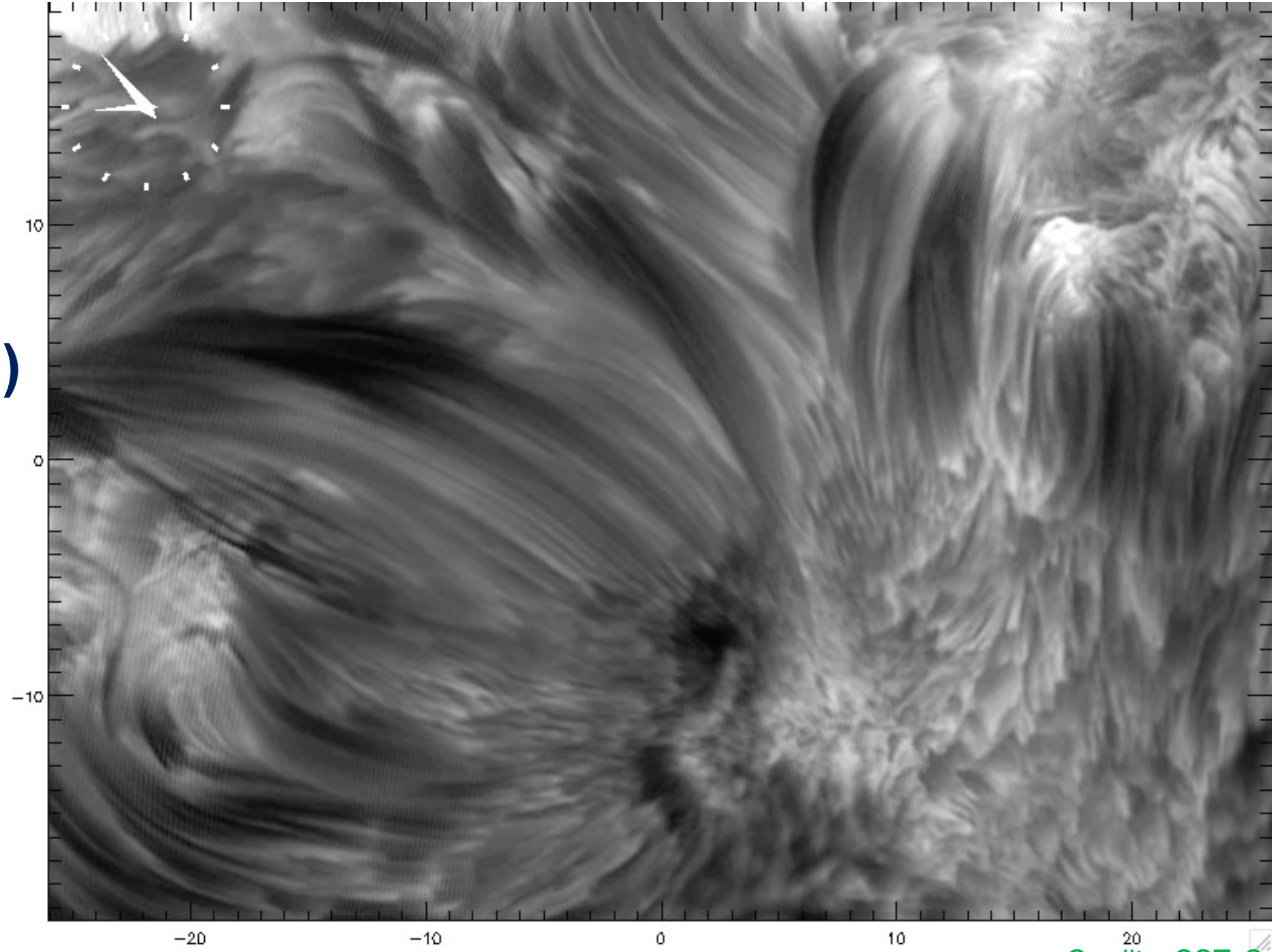

DST

Spectro-polarimetry



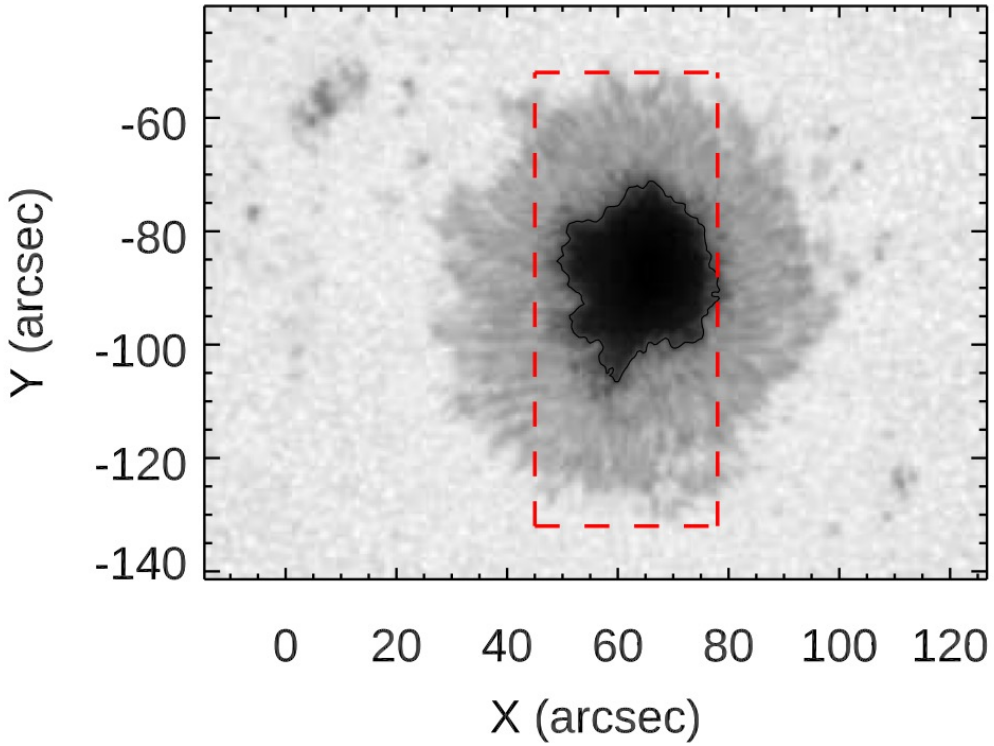
Credits: SST, S

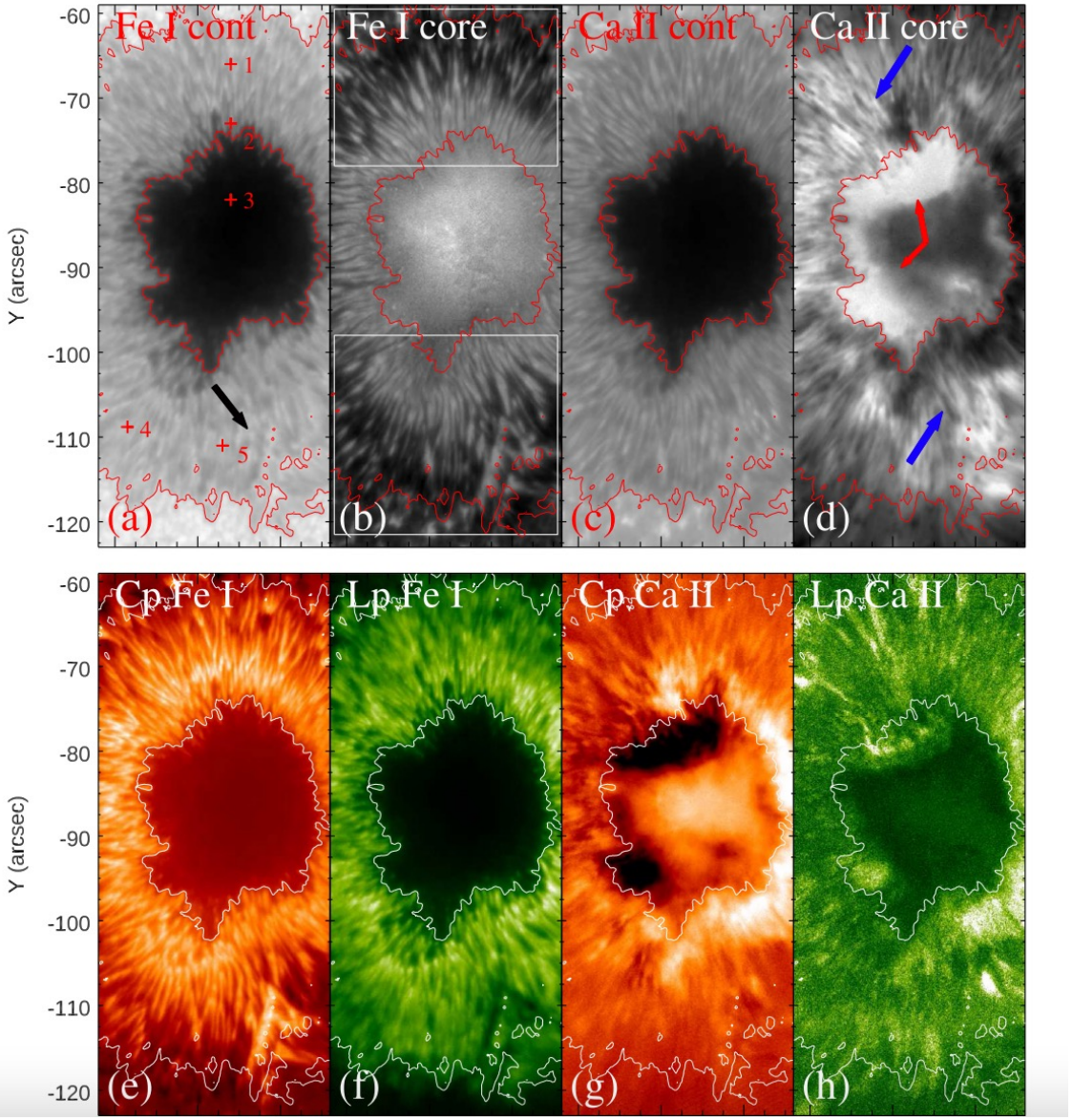
High-resolution (spectropolarim) imaging of the chromosphere



Credits: SST, S

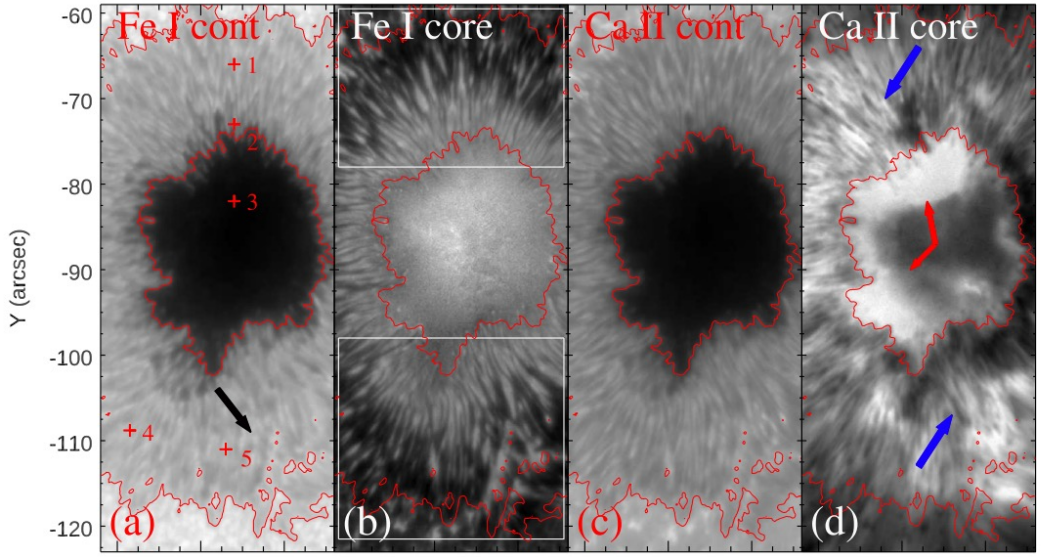
Height Dependence of the Penumbral Fine-scale Structure in the Inner Solar Atmosphere

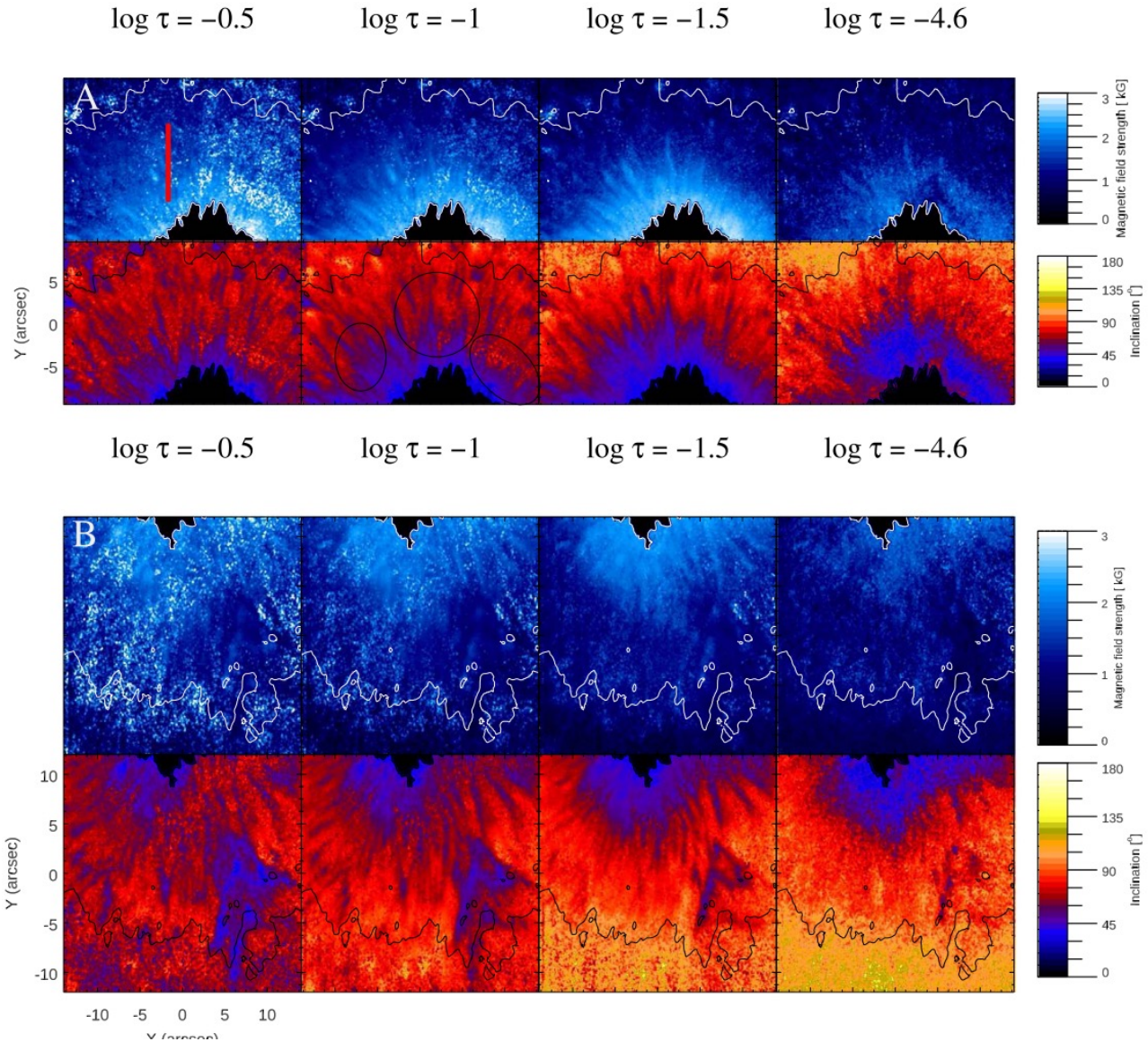




Murabito et al. 2019, A&A

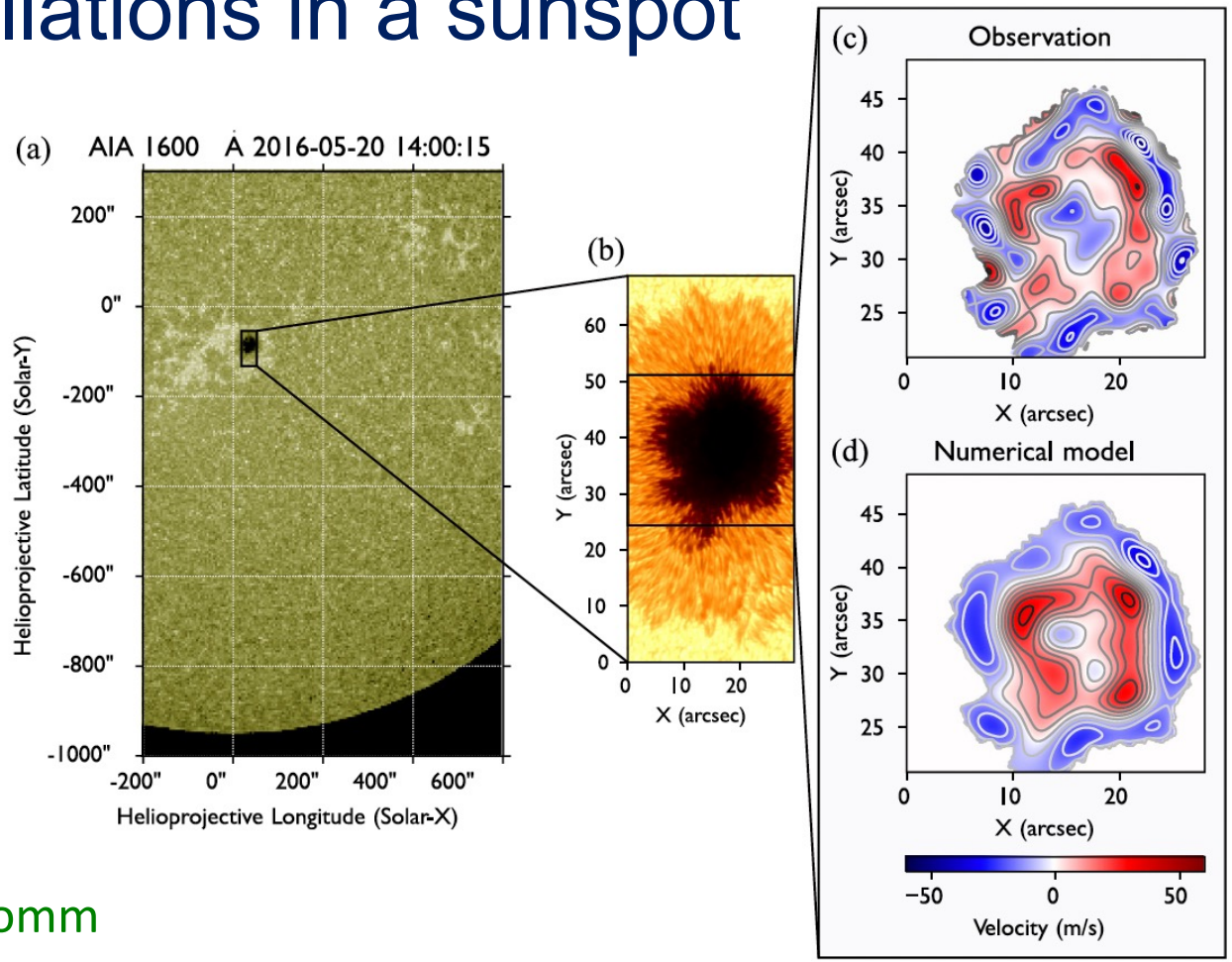
Height Dependence of the Penumbral Fine-scale Structure in the Inner Solar Atmosphere



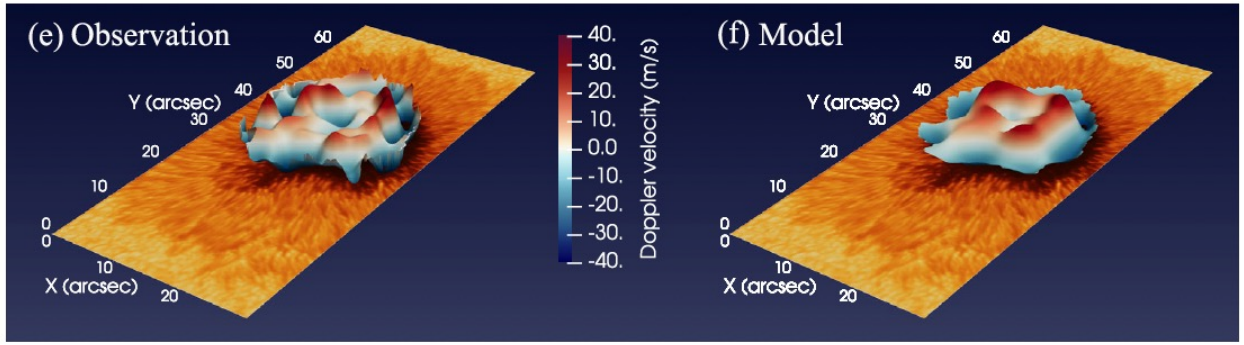


Murabito et al. 2019, A&A

Large scale coherent MHD oscillations in a sunspot



Stangalini et al. 2022, Nature Comm



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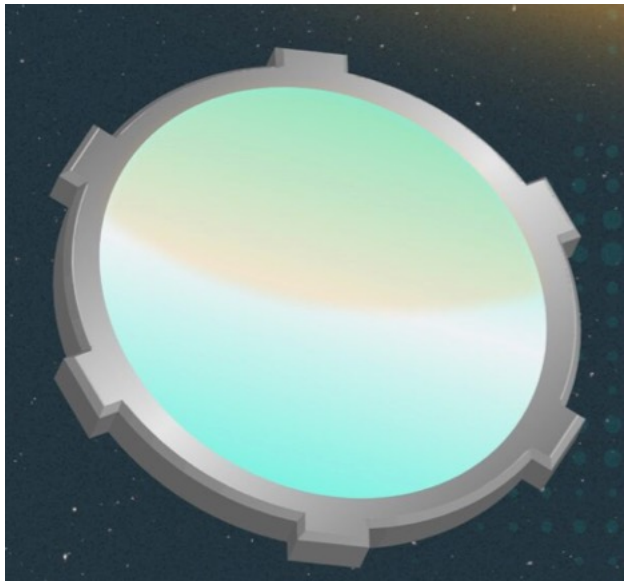
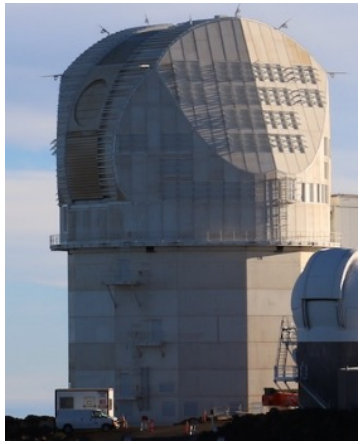


DKIST/4m



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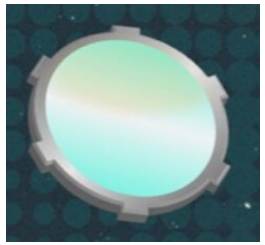
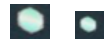


NGST/1.6m
GREGOR/1.5m

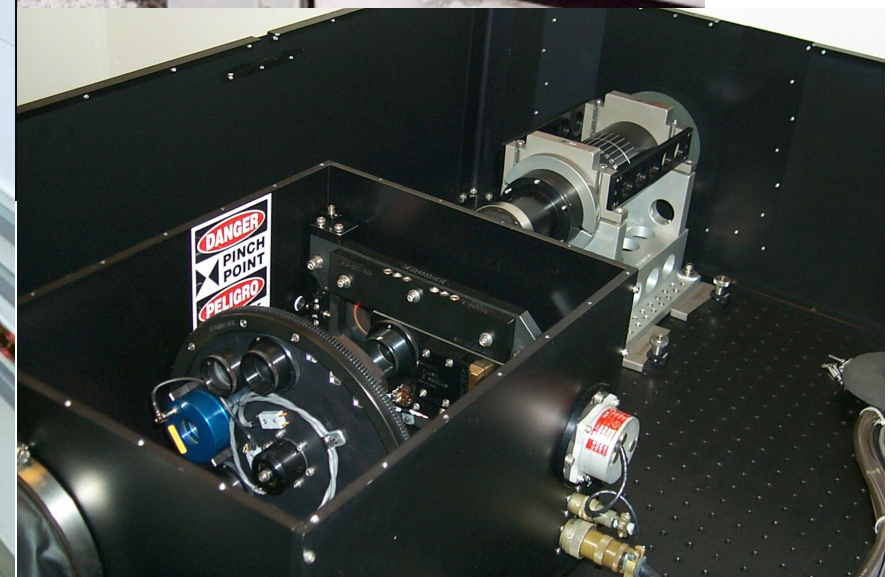
SST/1.m
THEMIS/0.9m

DST/0.7m
VTT/0.7m

SMALL



0.20m
0.03m



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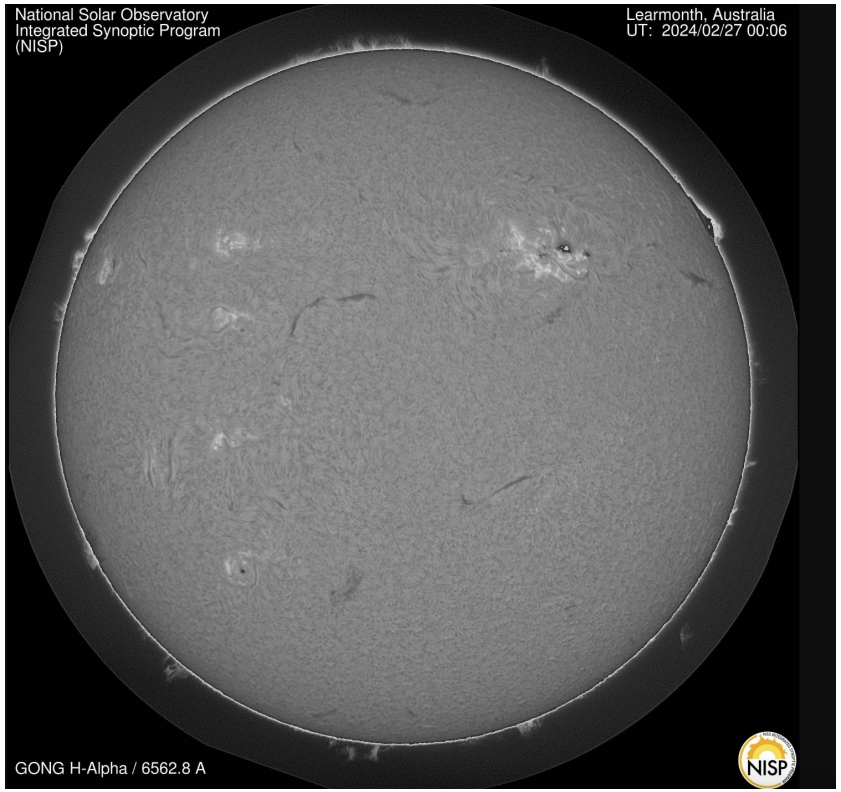
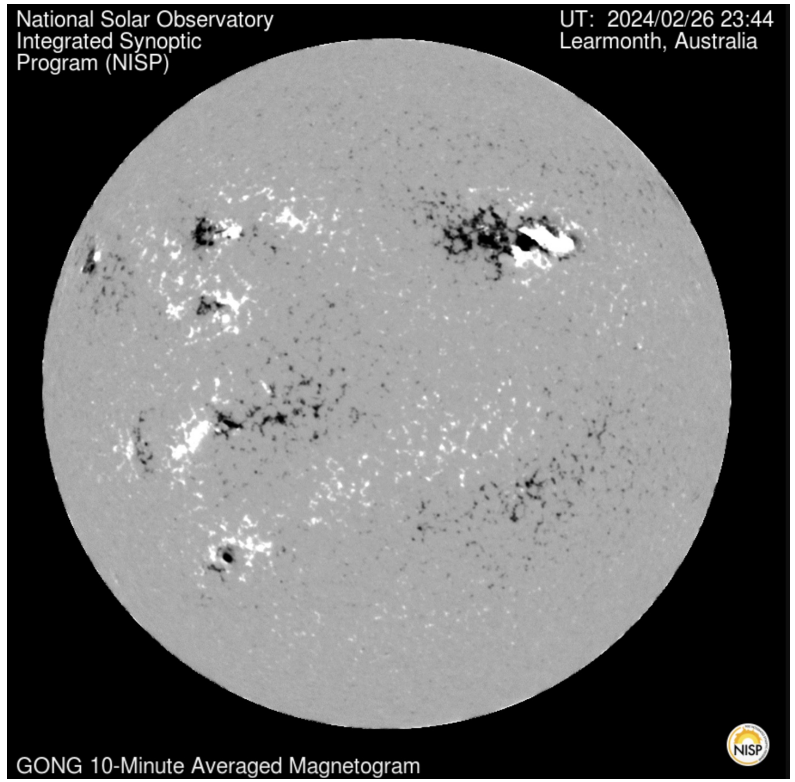
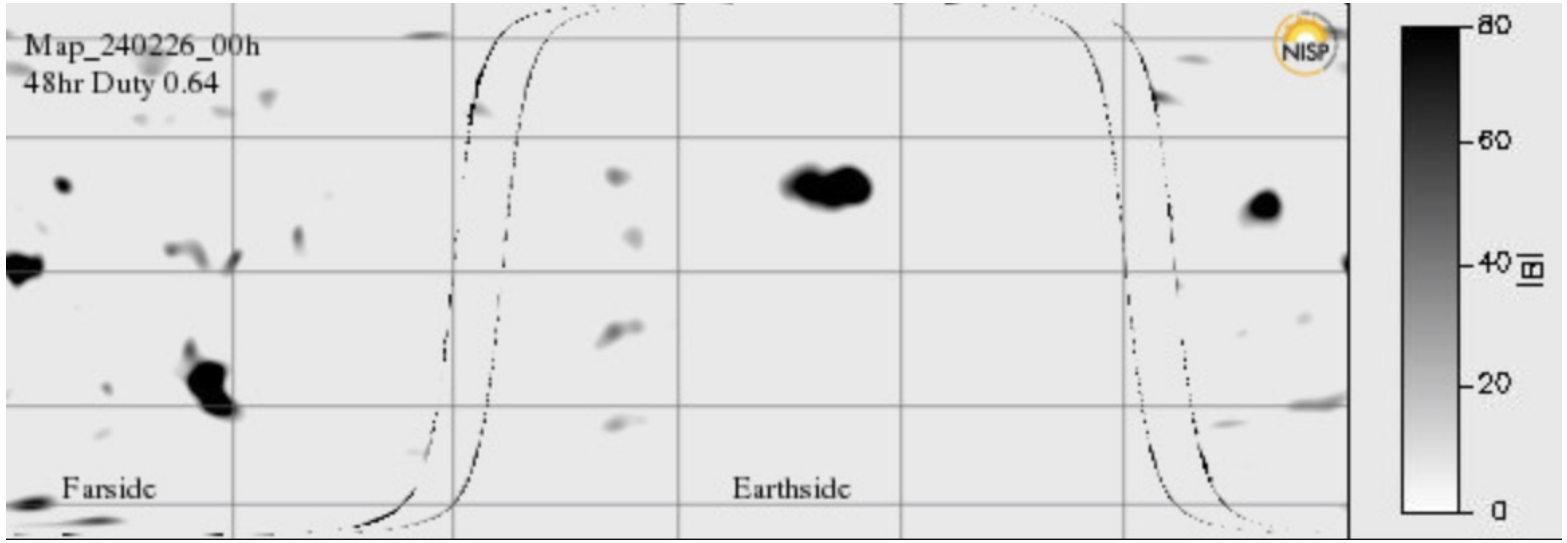






Ilaria Ermolli – INAF

Credits: GONG

www.SolarMonitor.org

Date Search

⇐20240225 ⇐Week ⇐Rotation

Main

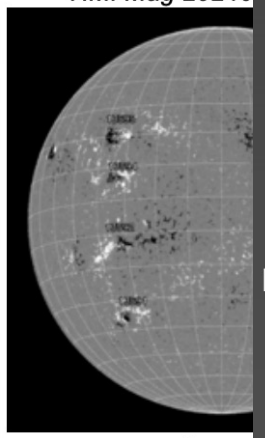
NOAA 6 Active Regions

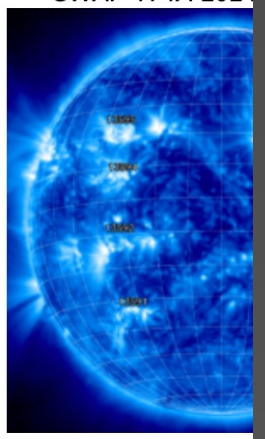
Flare Forecast

Coronal Holes

HMI Mag 20240

SWAP 174Å 2024





www.SolarMonitor.org

Date Search

⇐20240225 ⇐Week ⇐Rotation

Main

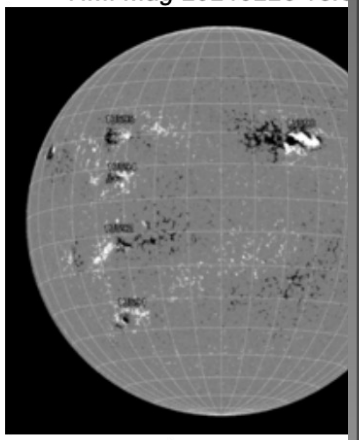
NOAA 6 Active Regions

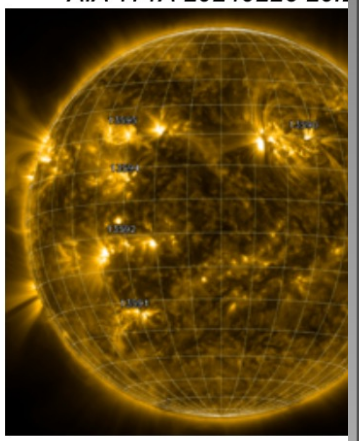
Flare Forecast

Coronal Holes

HMI Mag 20240226 18:5

AIA 171Å 20240226 20:





www.SolarMonitor.org

Date Search

⇐20240225 ⇐Week ⇐Rotation

26 February 2024

Today

NOAA Search

Rotation⇒ Week⇒ 20240227⇒

Main | Far-side | SDO short-wave | SDO long-wave

NOAA 6 Active Regions

Flare Forecast

Coronal Holes

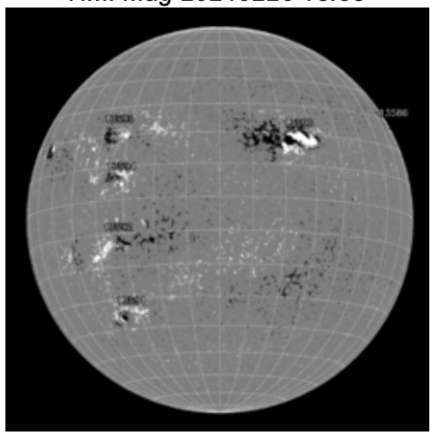
GOES

ACE

SDO/EVE

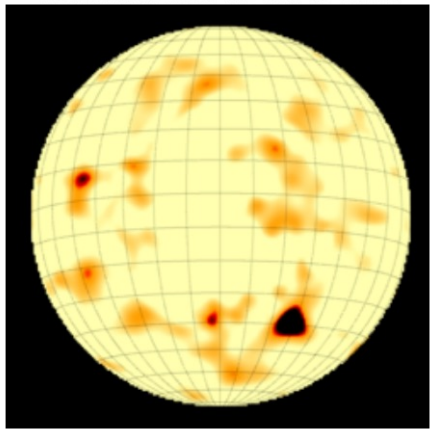
Events

HMI Mag 20240226 18:58



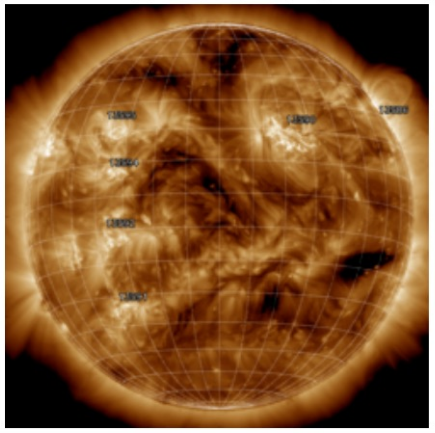
No Time Data Available

GONG Farside 20240225 12:00

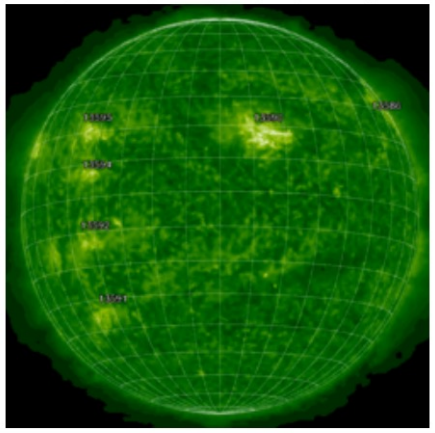


No Time Data Available

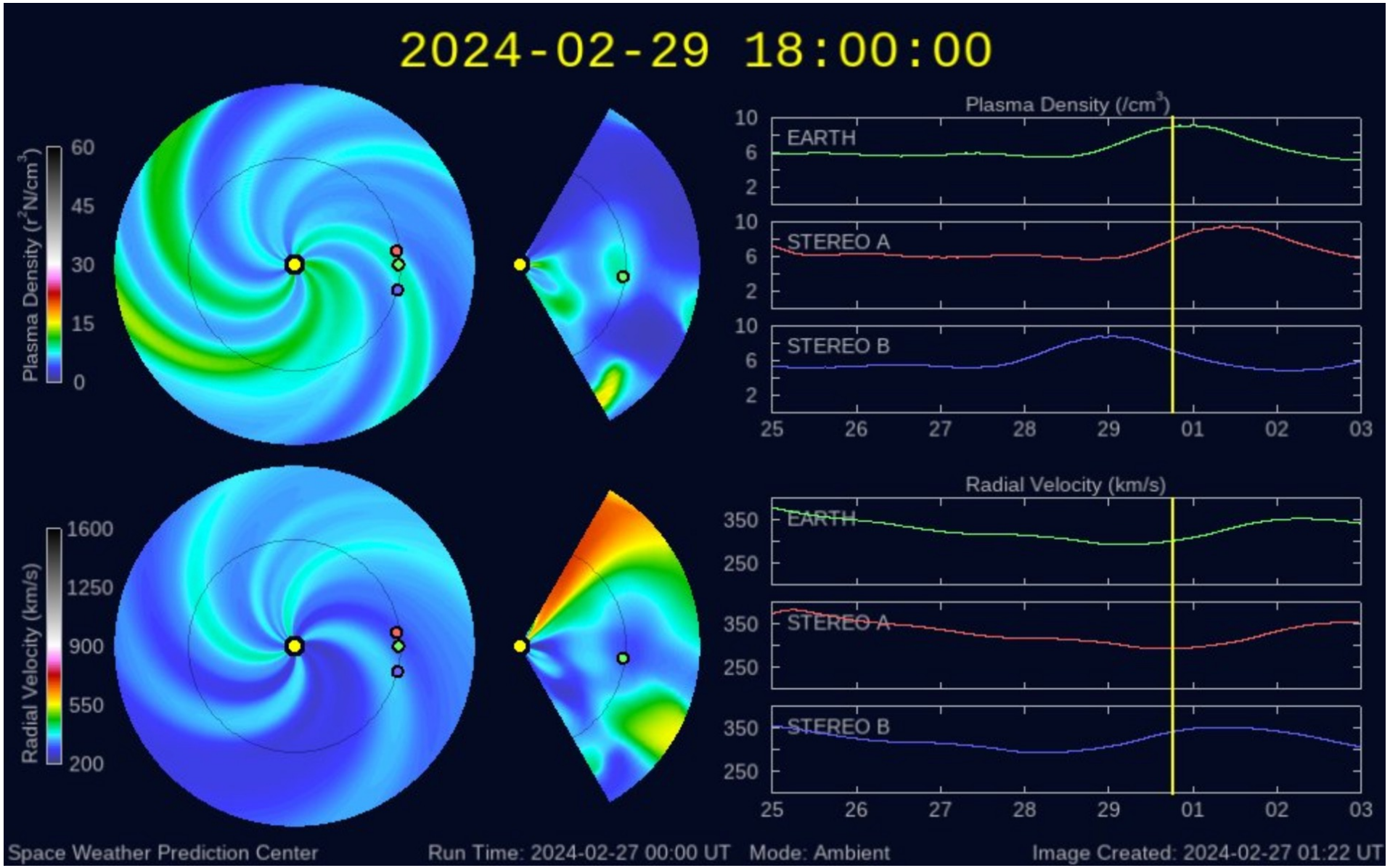
AIA 193Å 20240226 20:24



STEREO A 20240226 17:45



WSA-Enlil Solar Wind Prediction



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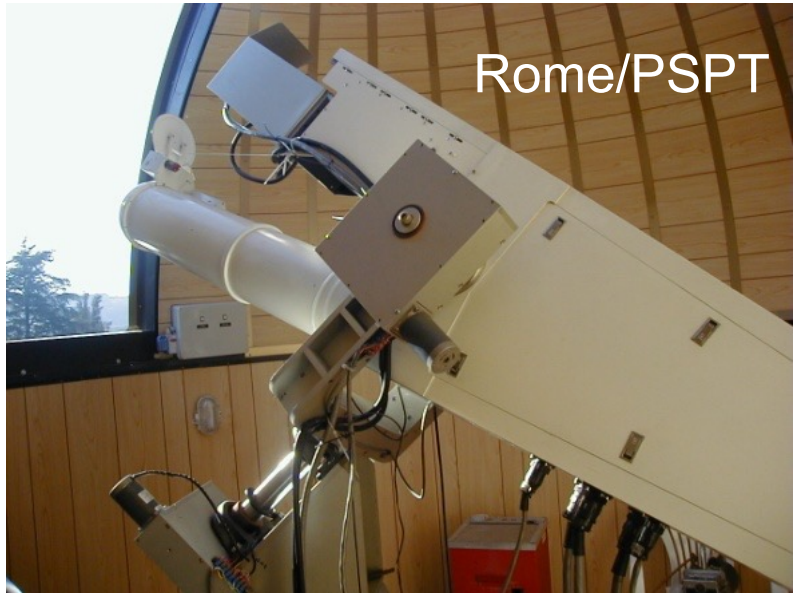
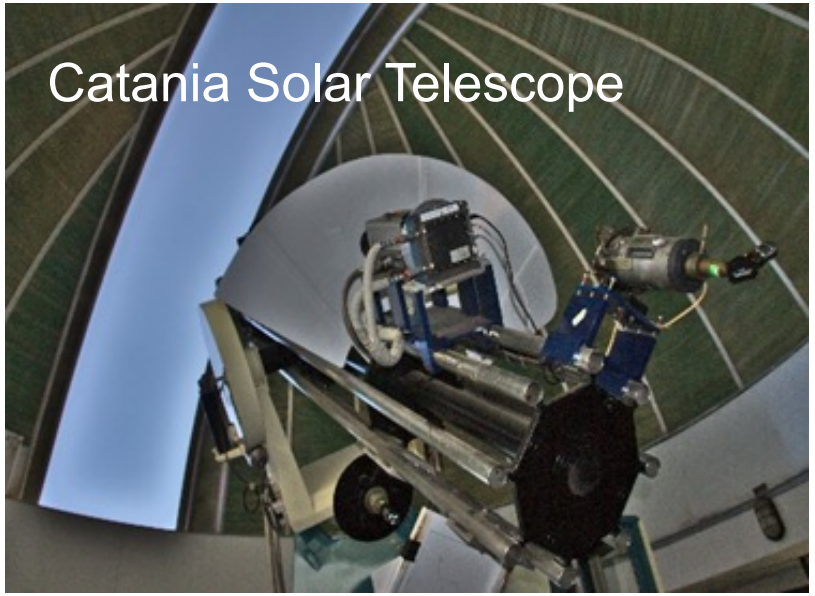
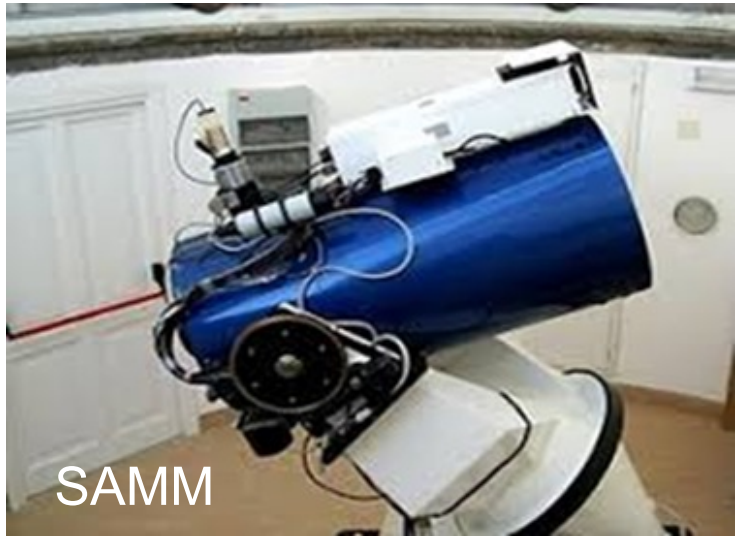
Credits: NOAA, USA

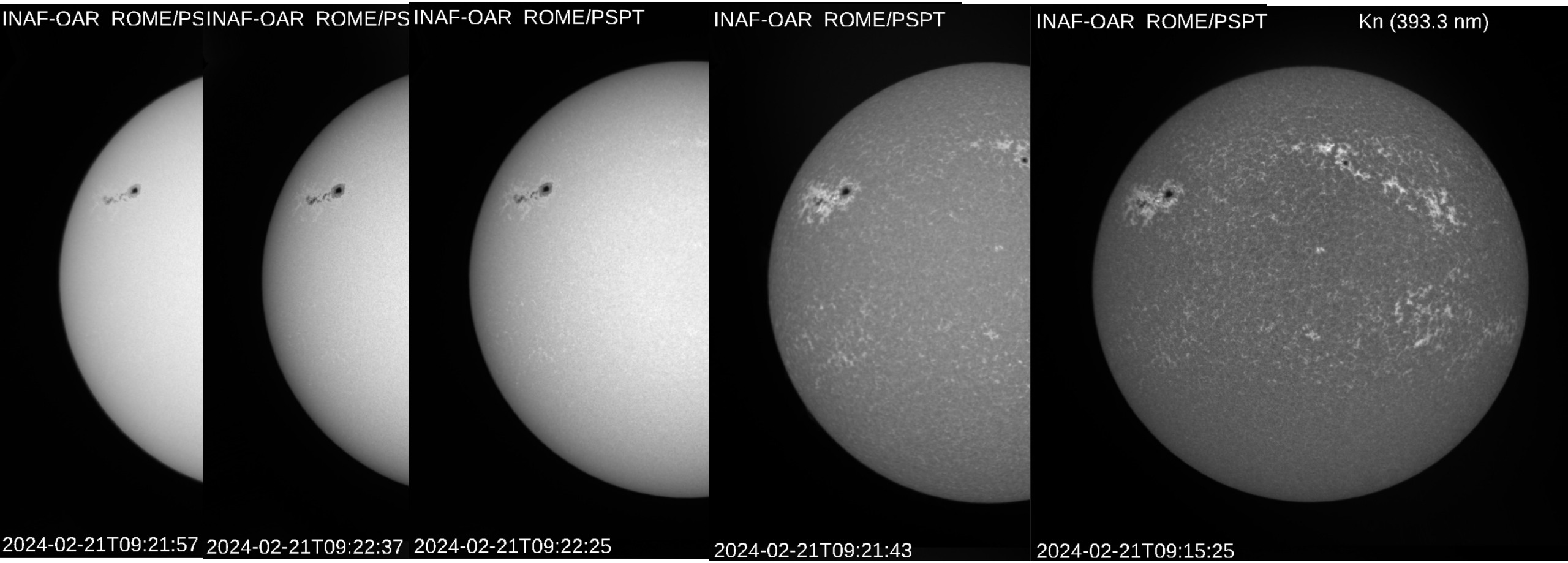






Ilaria Ermolli – INAF

Credits: INAF, I; ObsPM, F; KSO, A


INAF-OAR ROME/PS
2024-02-21T09:21:57
INAF-OAR ROME/PS
2024-02-21T09:22:37
INAF-OAR ROME/PSPT
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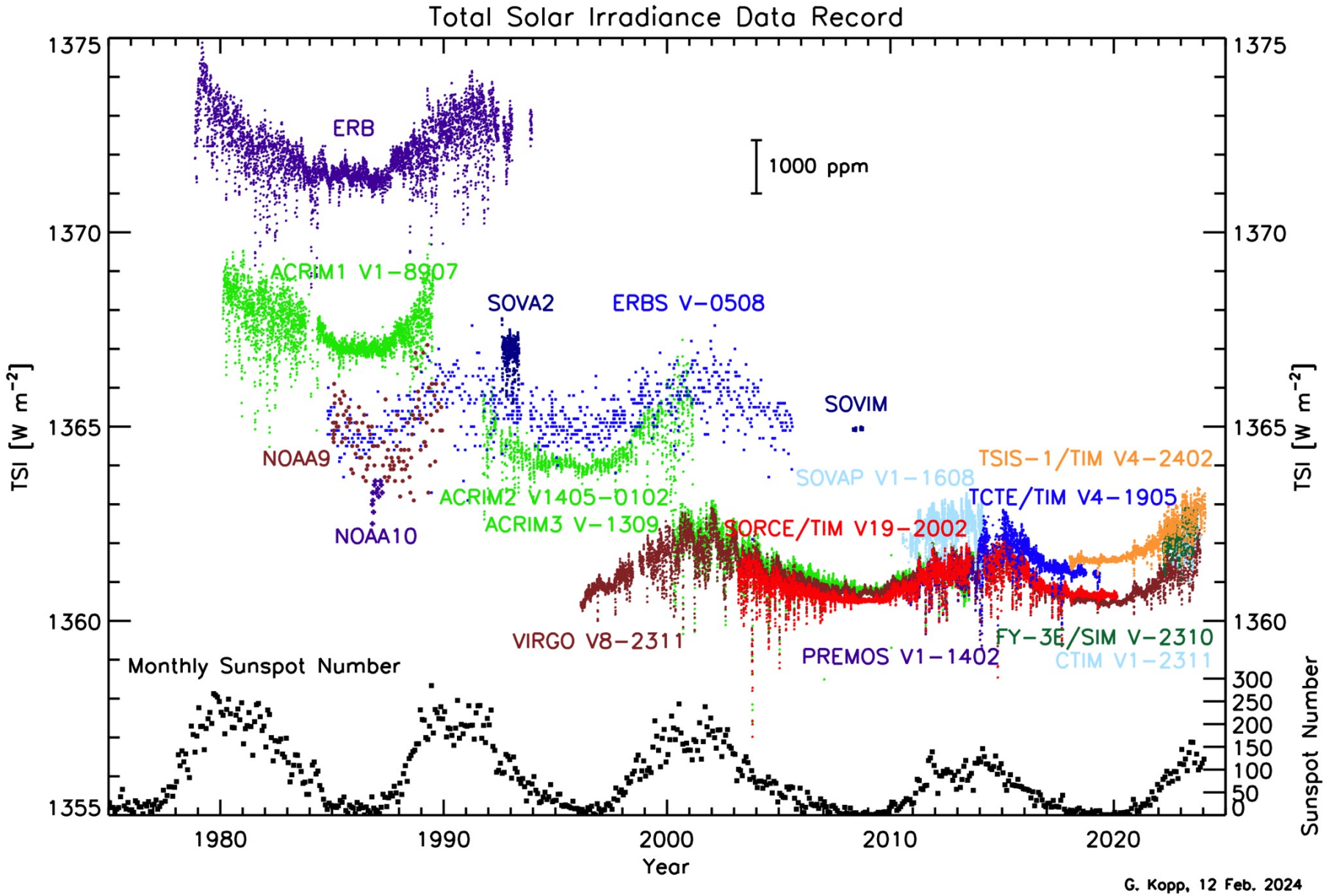
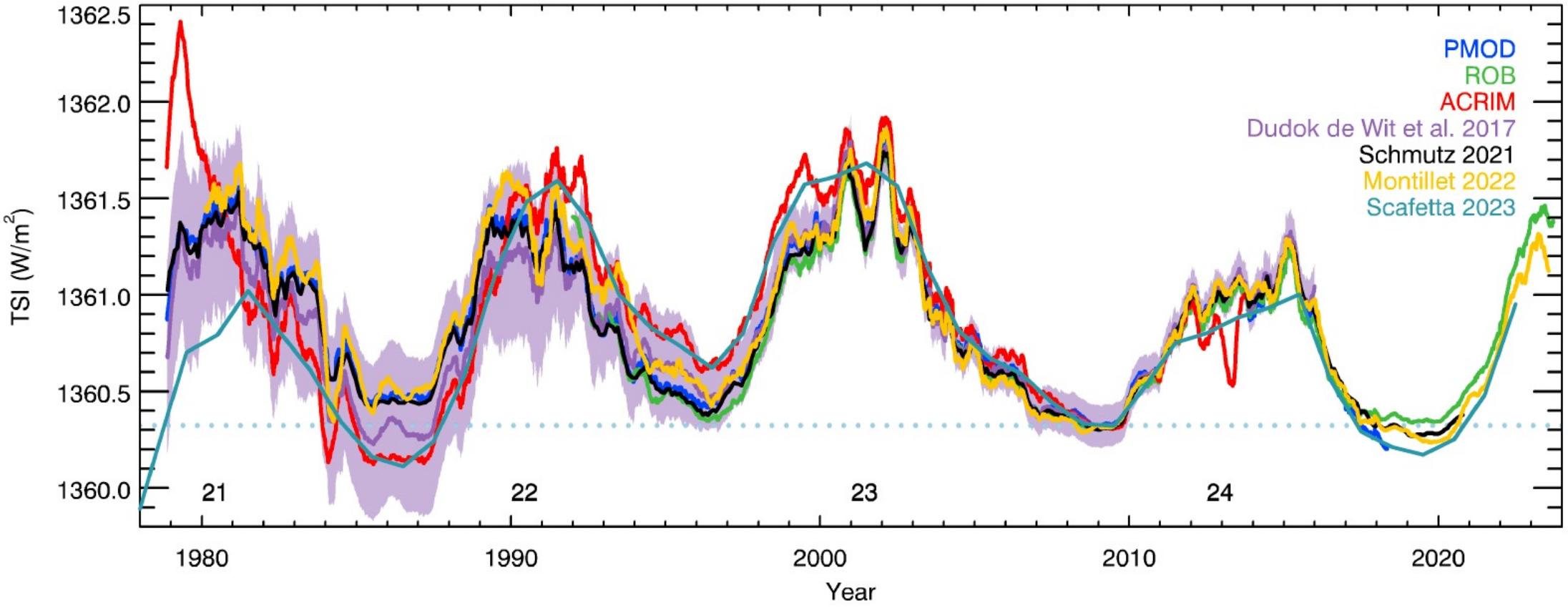
INAF-OAR ROME/PSPT
2024-02-21T09:21:43
INAF-OAR ROME/PSPT
Kn (393.3 nm)
2024-02-21T09:15:25

Credits: Greg Kopp Webpage, USA

Total Solar Irradiance measurements

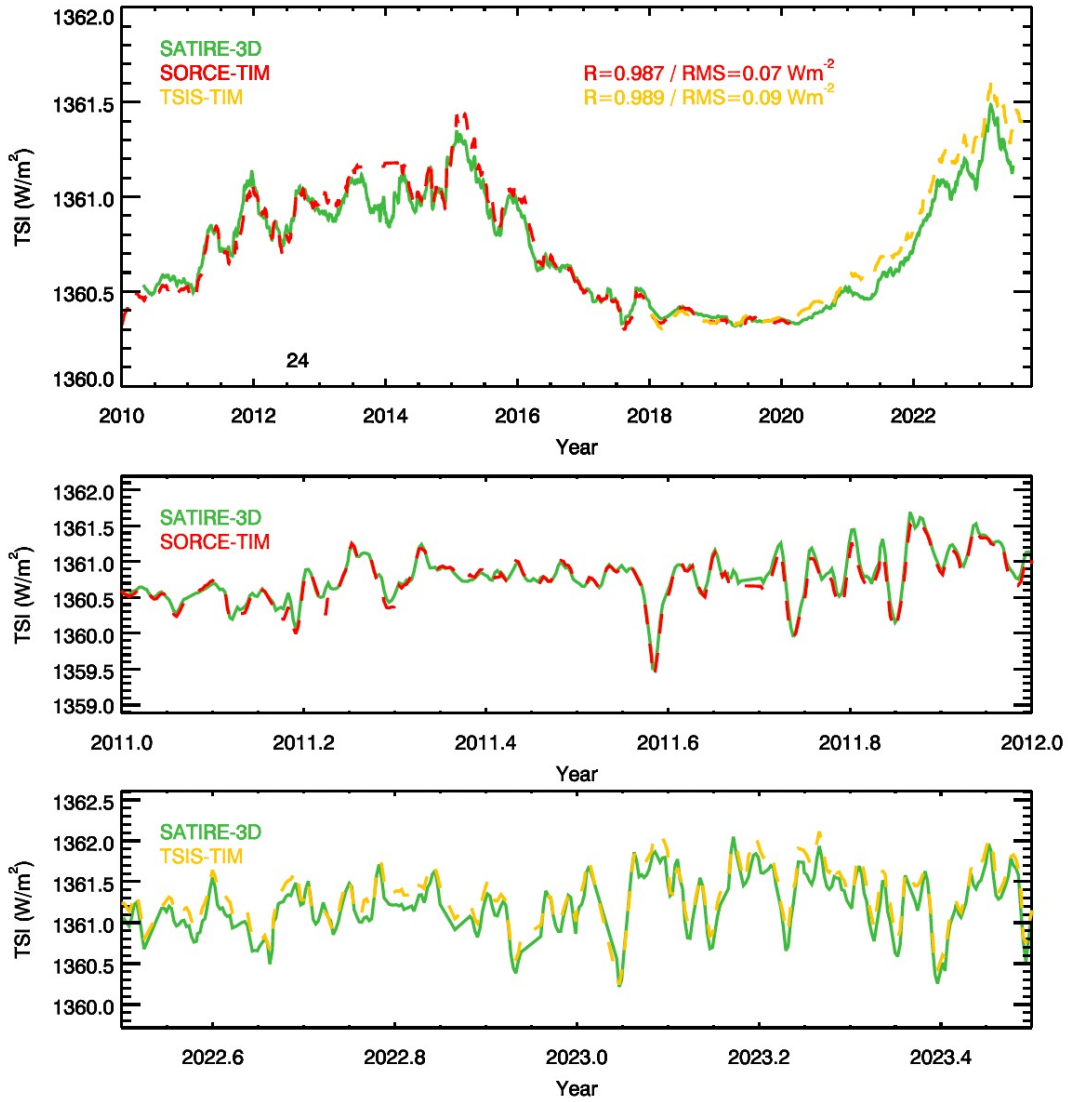


Total Solar Irradiance variations 1978-present



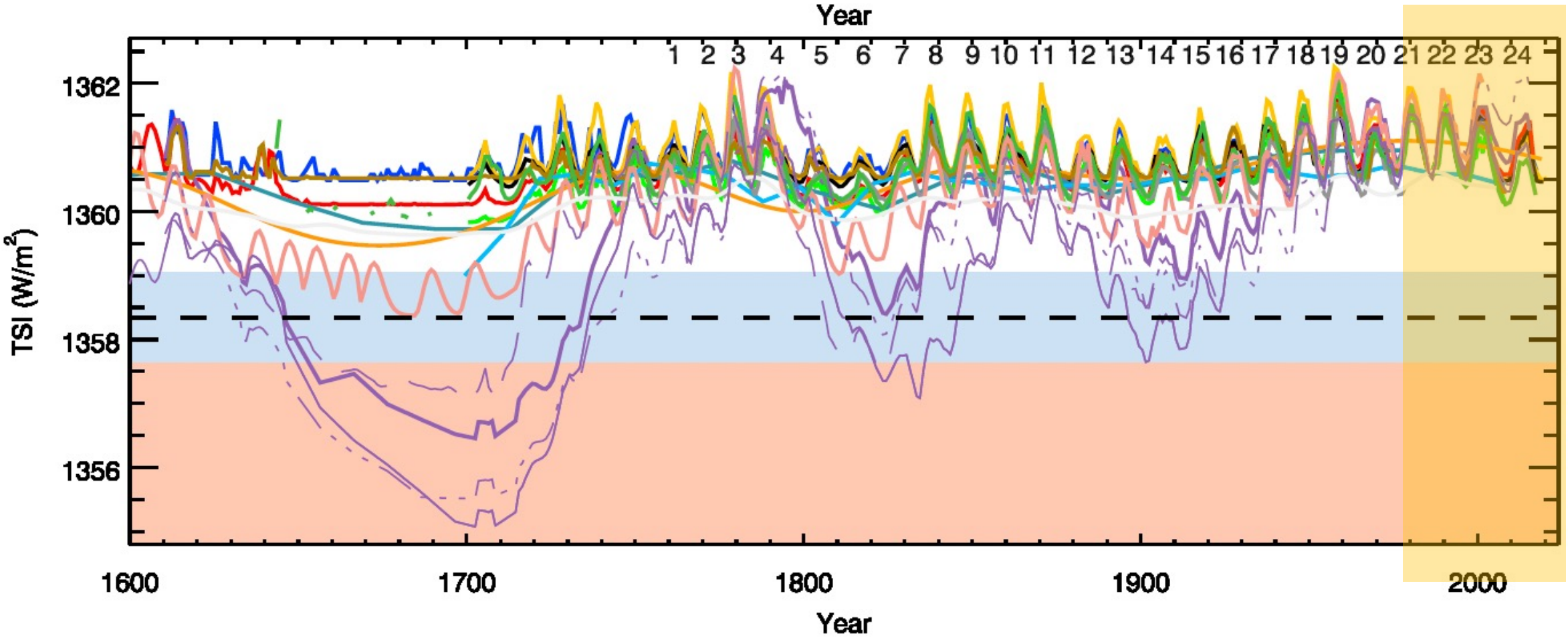
Chatzistergos et al. 2023, JASP

Total Solar Irradiance reconstructions based on magnetograms



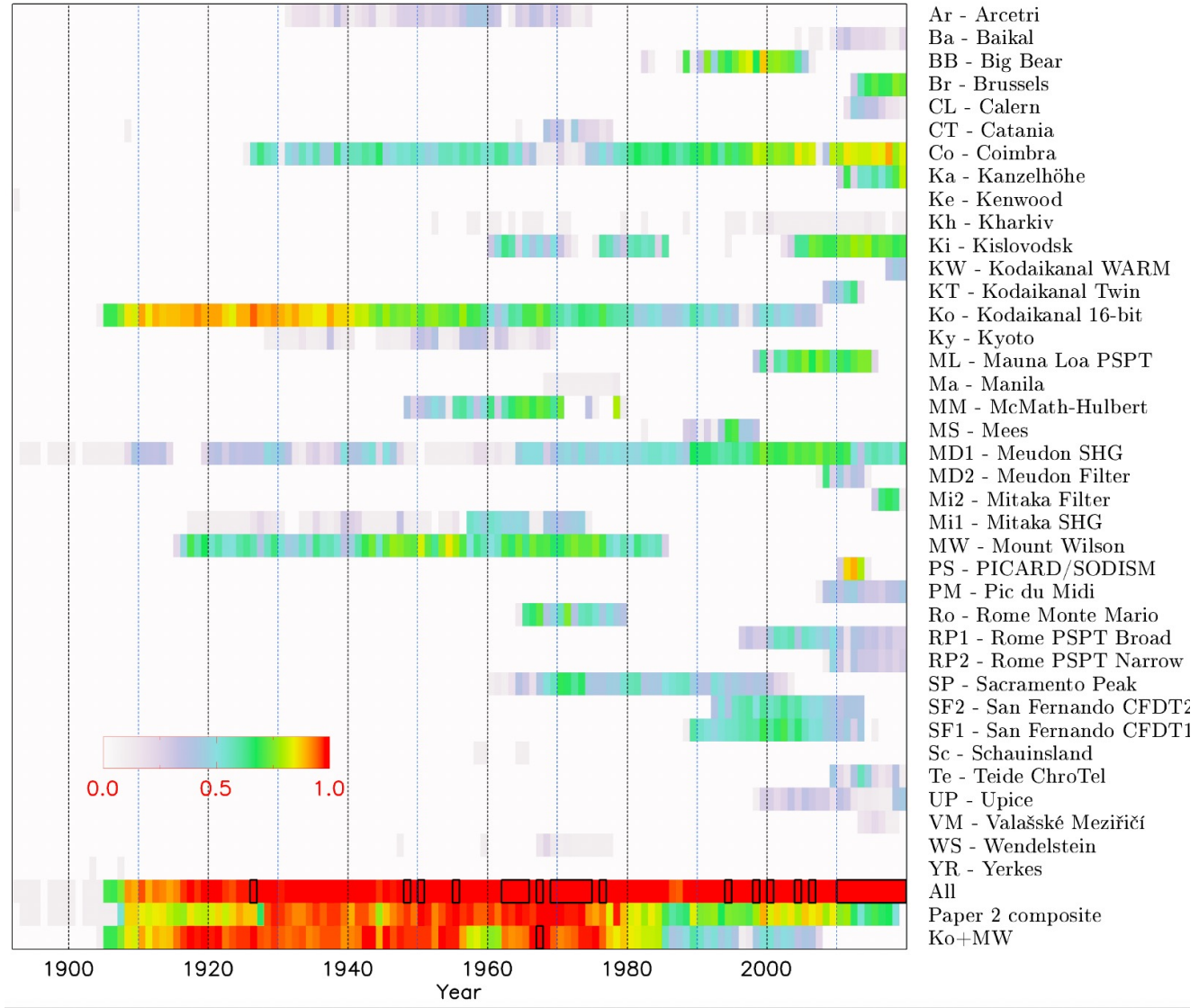
Chatzistergos et al. 2023, JASP

Current estimates Total Solar Irradiance variations back to 1600



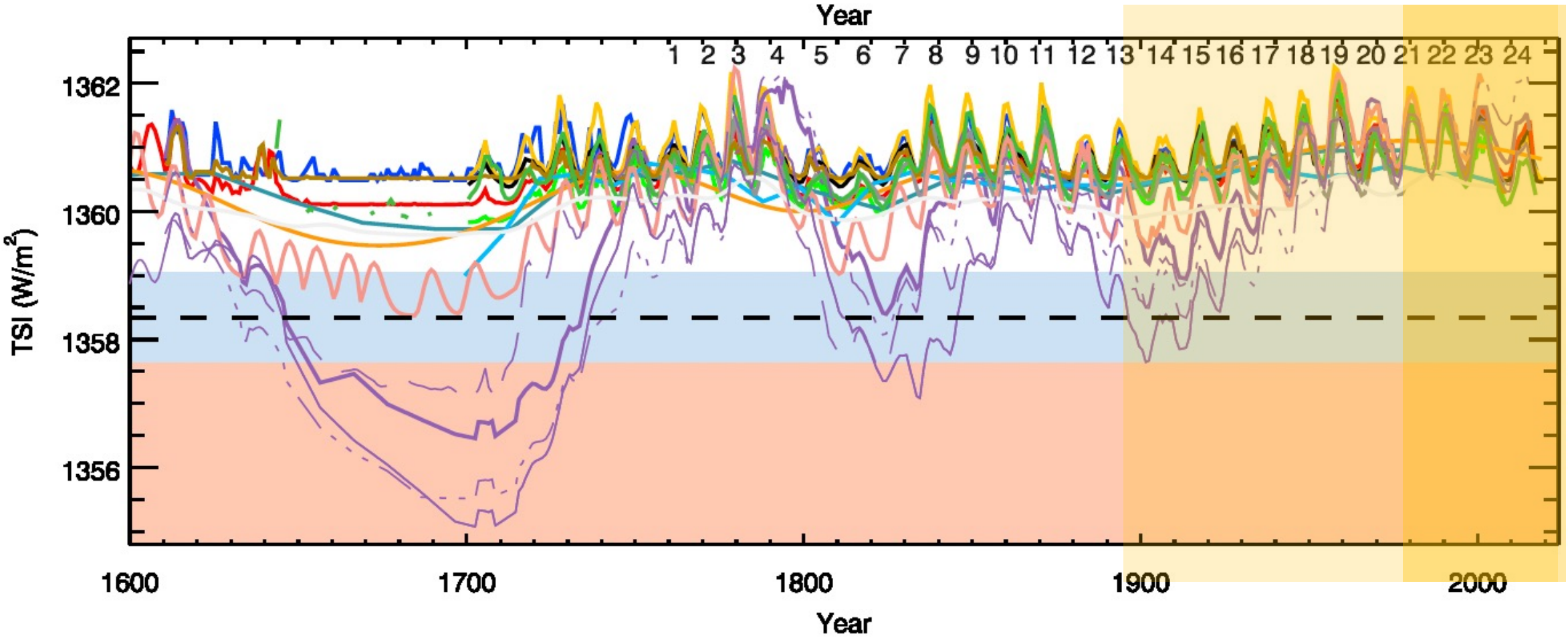
Adapted from Chatzistergos et al. 2023, JASP

Ca II K observations 1892-present



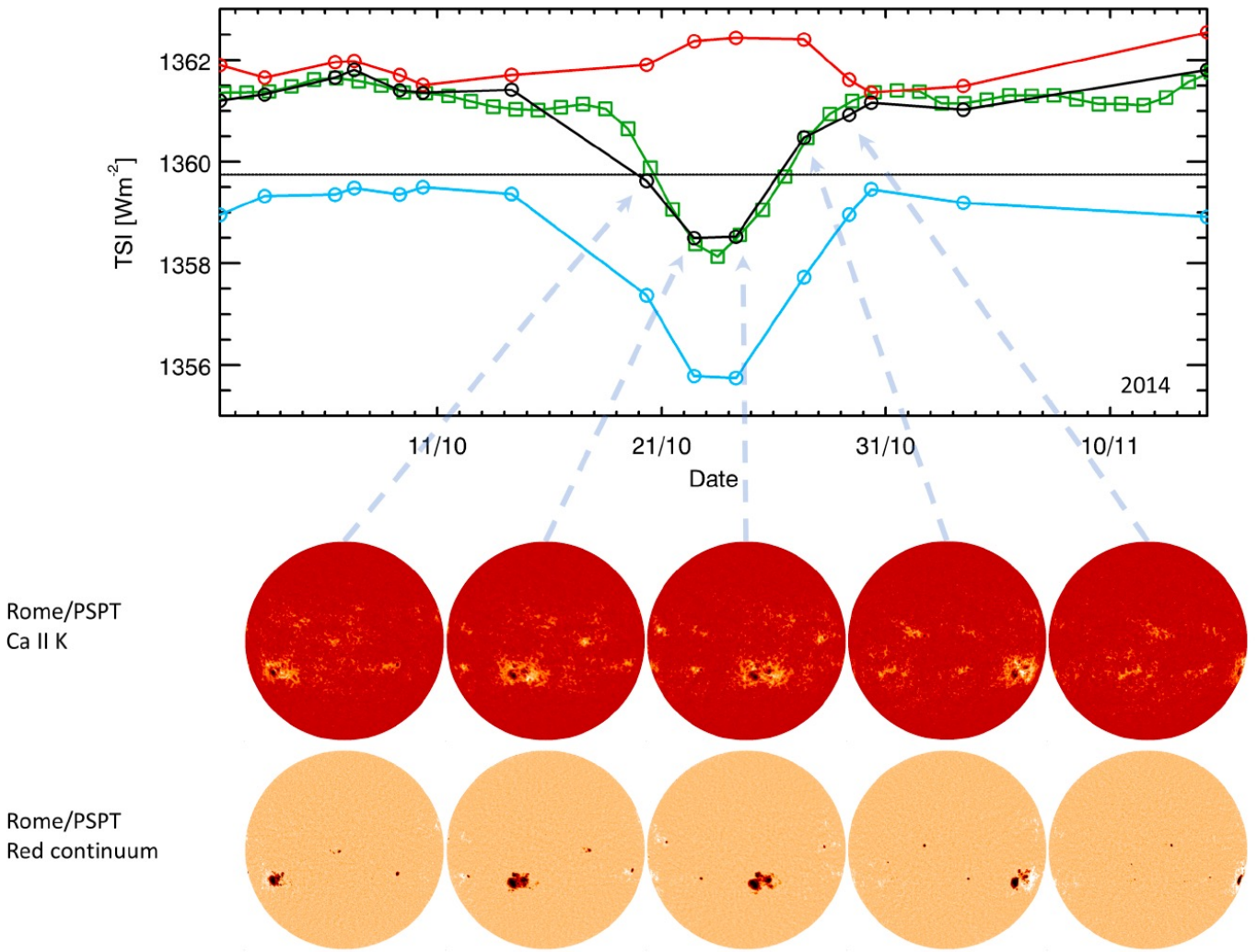
Chatzistergos et al. 2020, A&A

Current estimates Total Solar Irradiance variations back to 1600



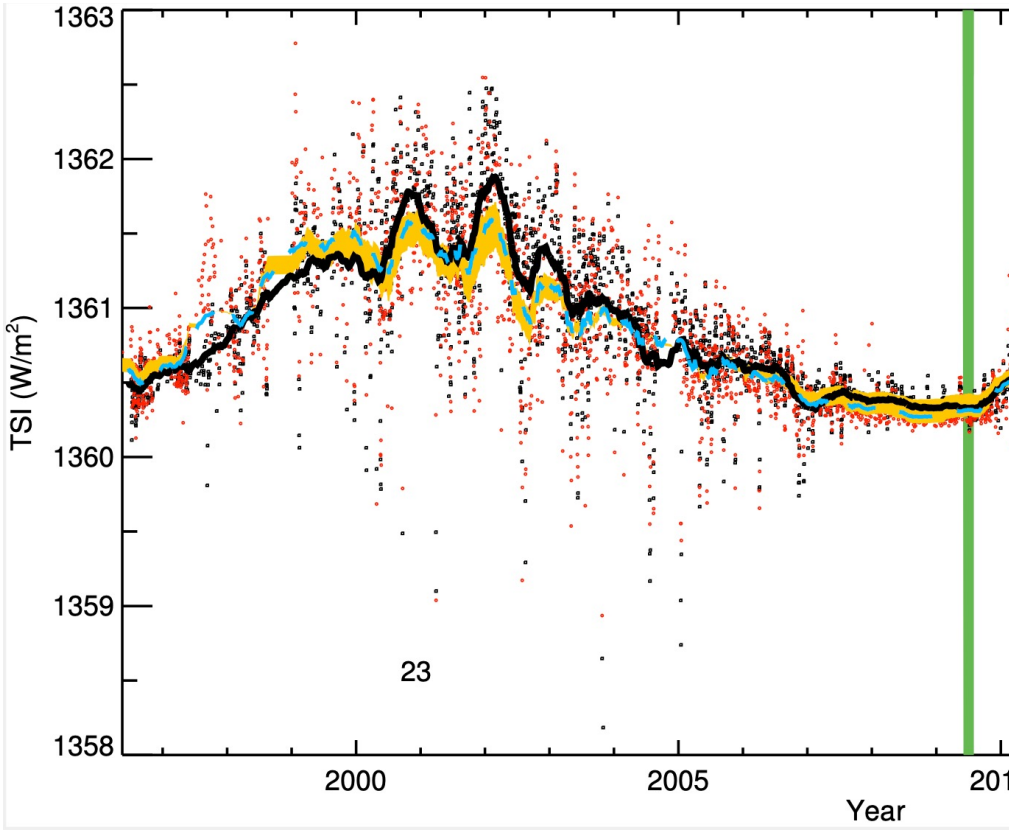
Adapted from Chatzistergos et al. 2023, JASP

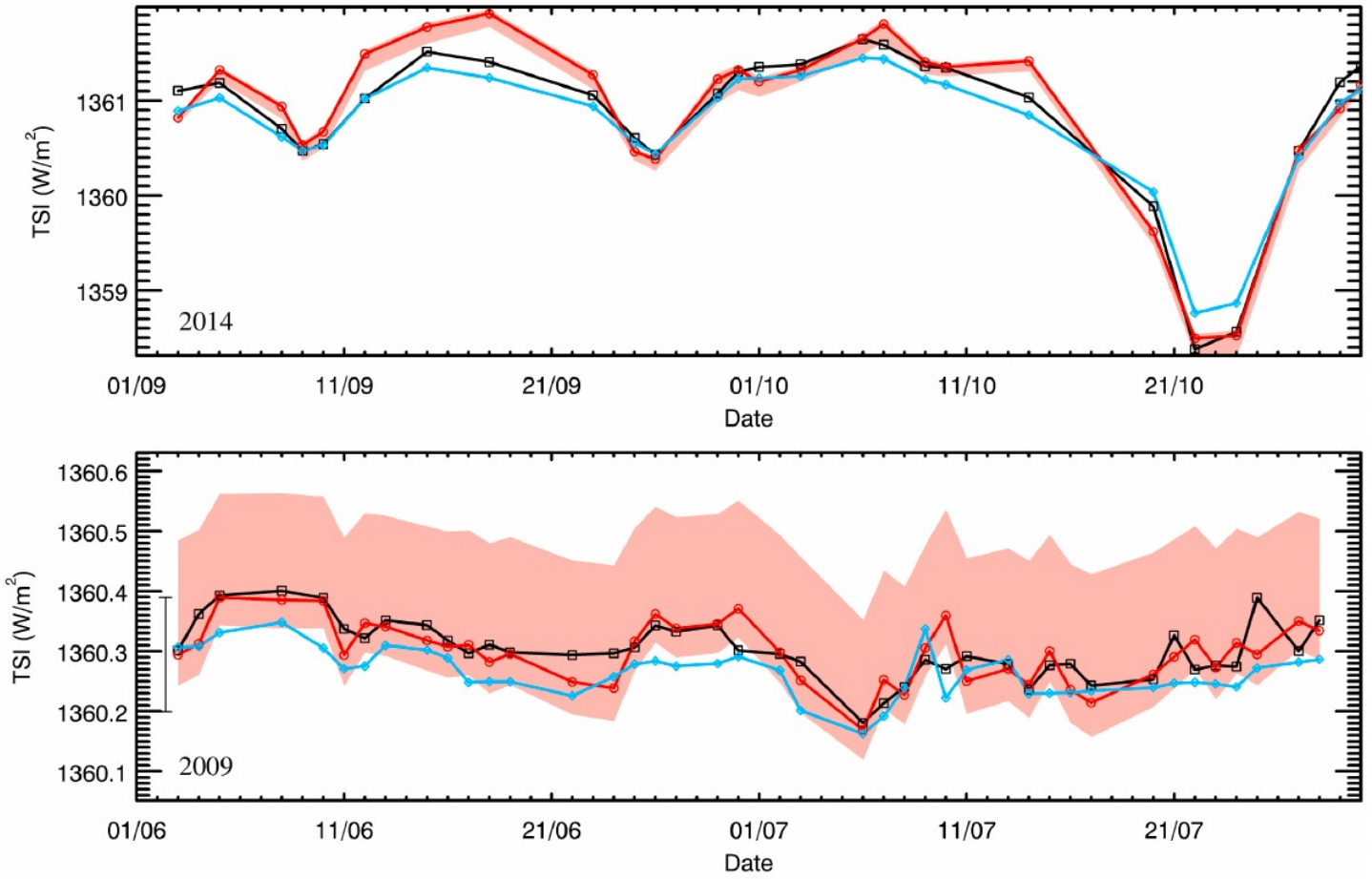
Total Solar Irradiance reconstructions based on CaIIK+red images



Chatzistergos et al. 2023, JASP

Total Solar Irradiance reconstructions based on CaIIK+red images





Chatzistergos et al. 2021, A&A

Black = TSI measurements

Ciel = magn based reconstruction

Yellow/Red = CaIIK+red based reconstruction

SCIENCE

Helioseismology as a window to the Sun's **far side and interior**

Nature of solar/stellar **magnetic fields**

Solar Eruptions and Space Weather

Magnetic connectivity throughout the heliosphere

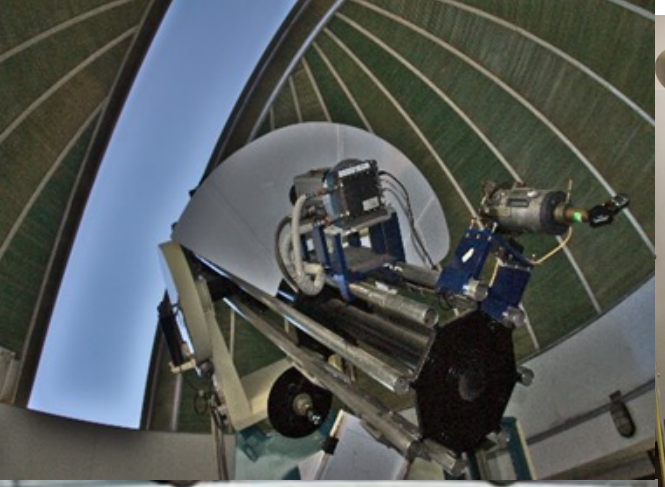
Context images for high-resolution obs and space missions

Sun-as-a-star research --> next talk!

BROADER IMPACT

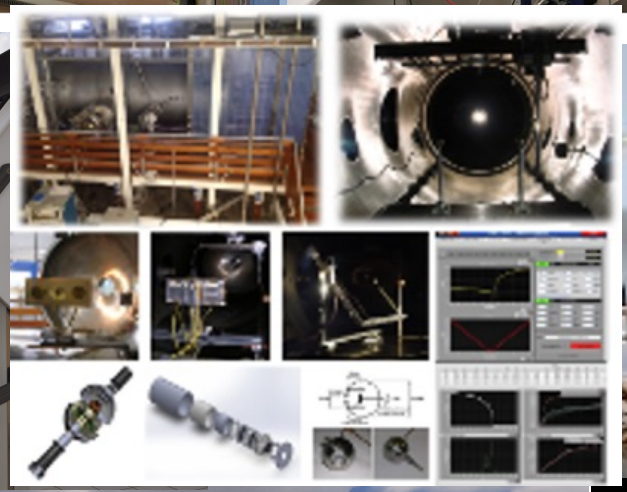
Earth's Climate Studies

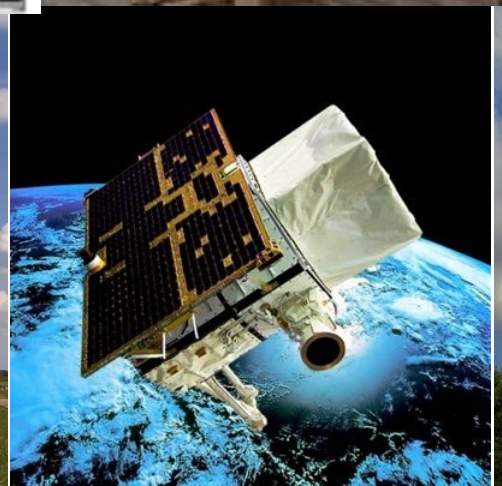
Space Weather Operations Services




PERICOLO
CORRENTE
ELETTRICA


MERLINO





Thank you!