Variabilità solare

VARSOL

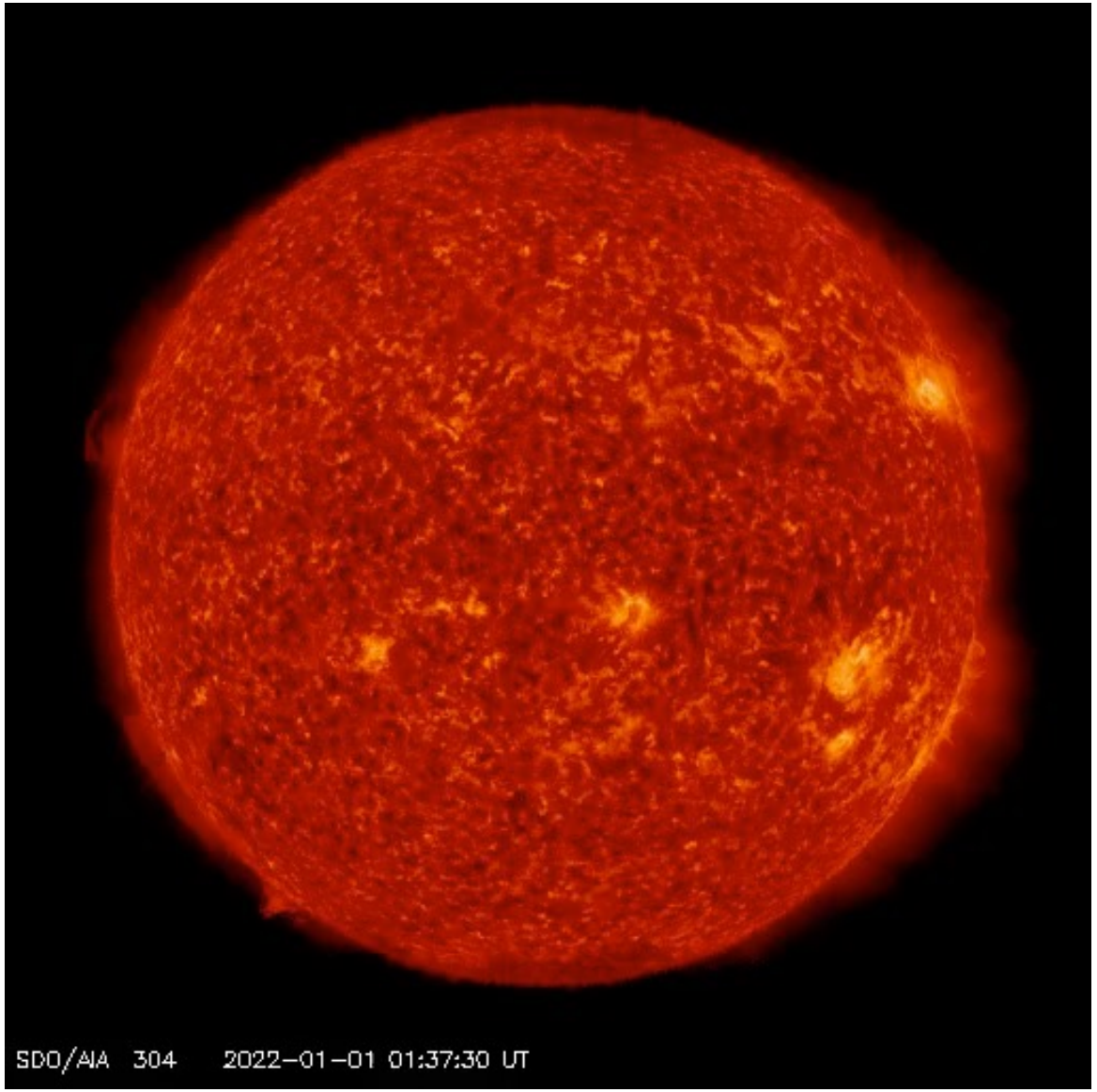
Ilaria Ermolli

INAF Osservatorio Astronomico di Roma

INAF Audizioni CSN3 – 9 Maggio 2022

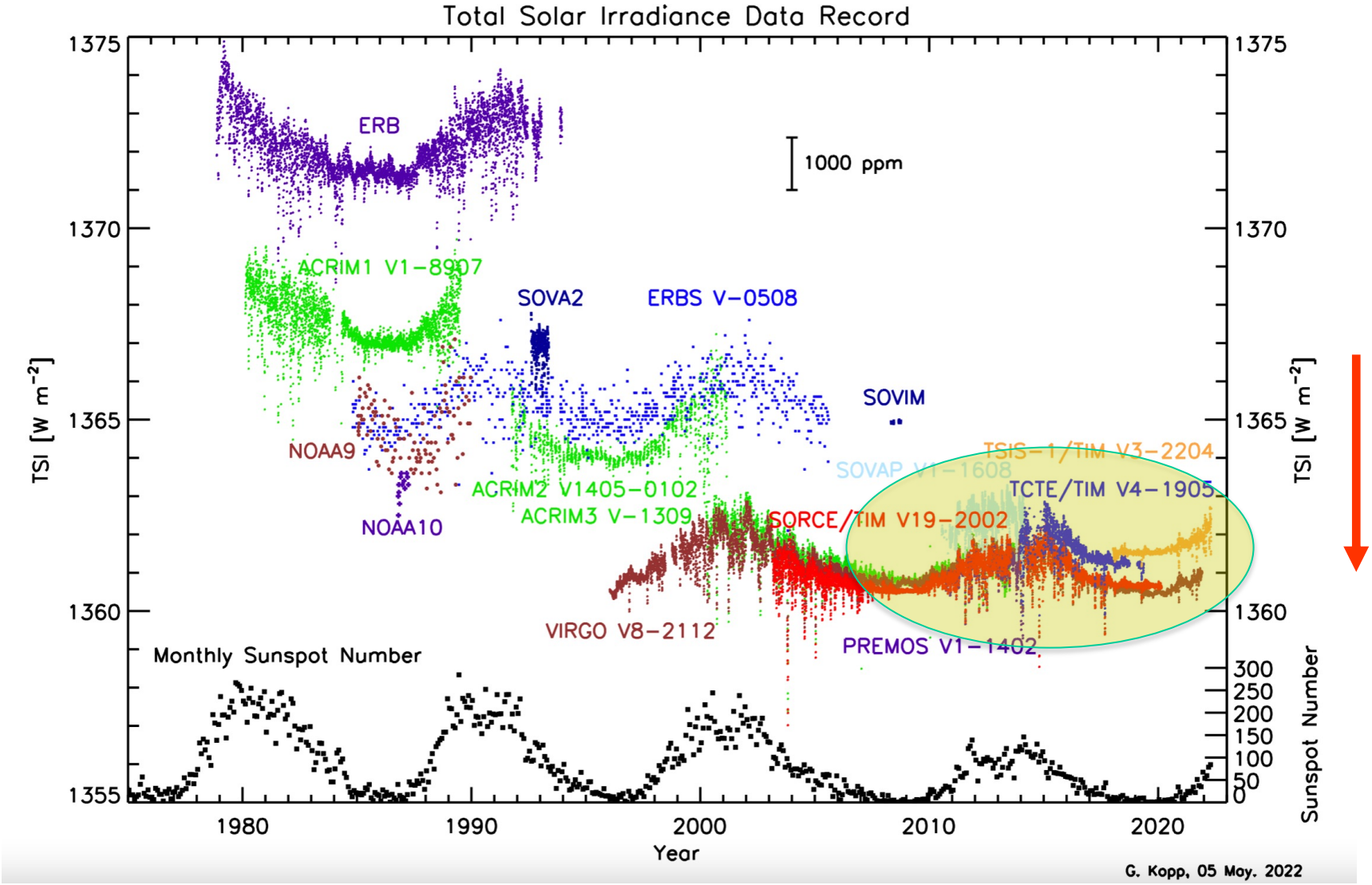
THE SUN IS A VARIABLE STAR

At all spatial, spectral, and temporal scales



THE RADIATIVE ENERGY VARIES

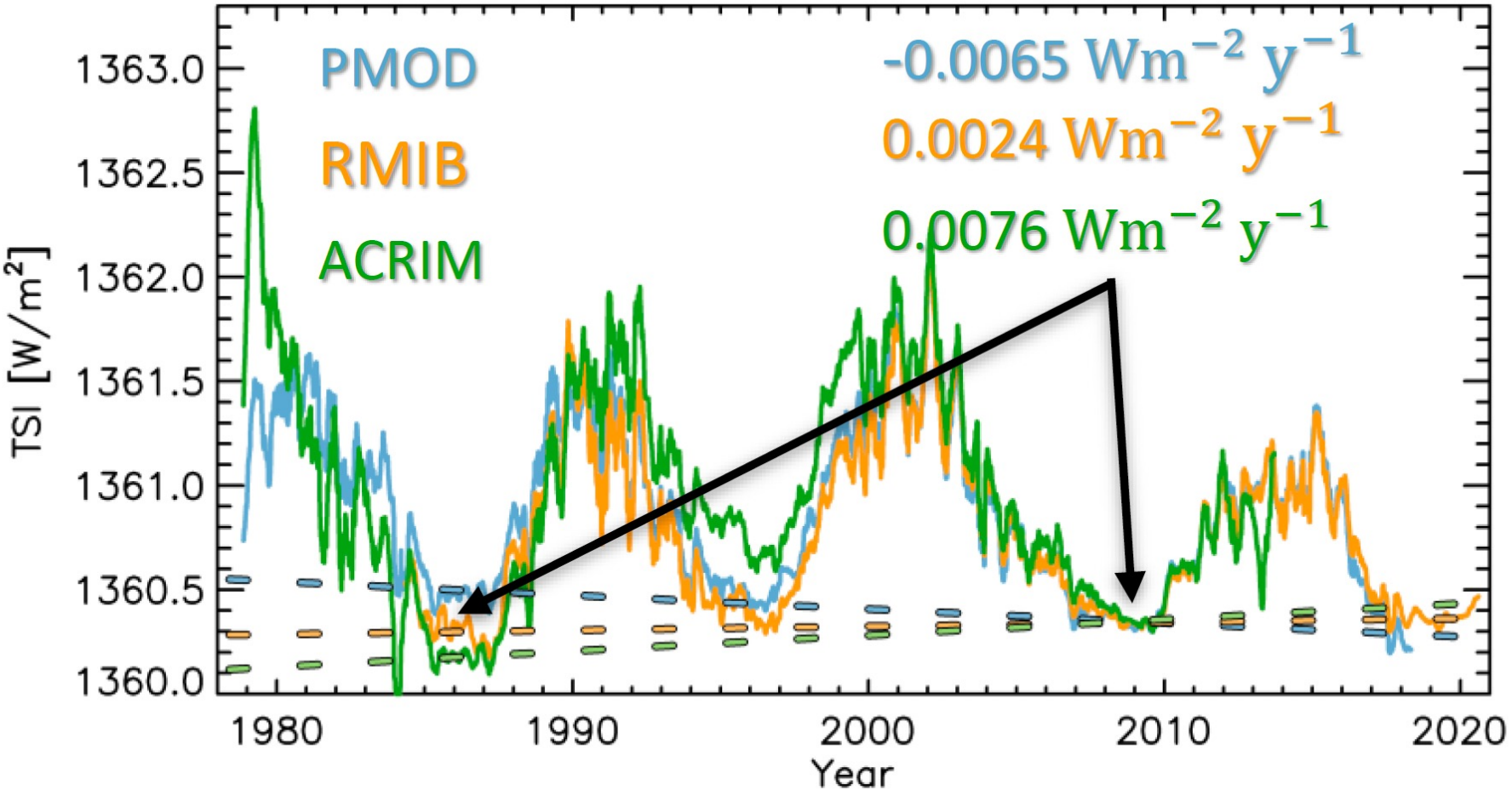
TSI changes in phase with the solar magnetic activity



http://spot.colorado.edu/~koppg/TSI/

CURRENT KNOWLEDGE OF TOTAL SI

Trend over the past 4 solar minima is uncertain

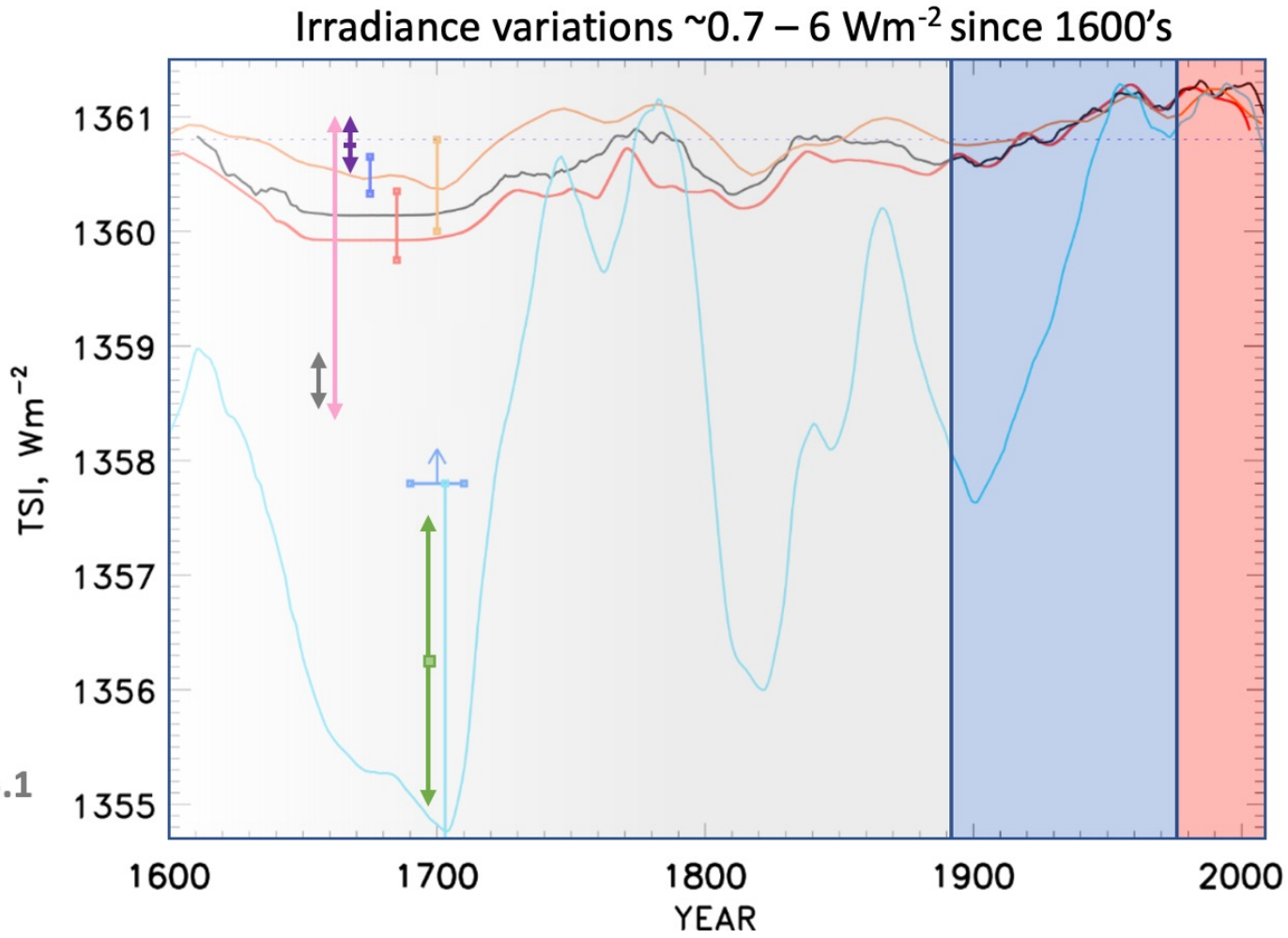


Adapted from Yeo et al. 2014, SSRv

CURRENT KNOWLEDGE OF TSI LONG-TERM TREND

Large uncertainty going further back in time

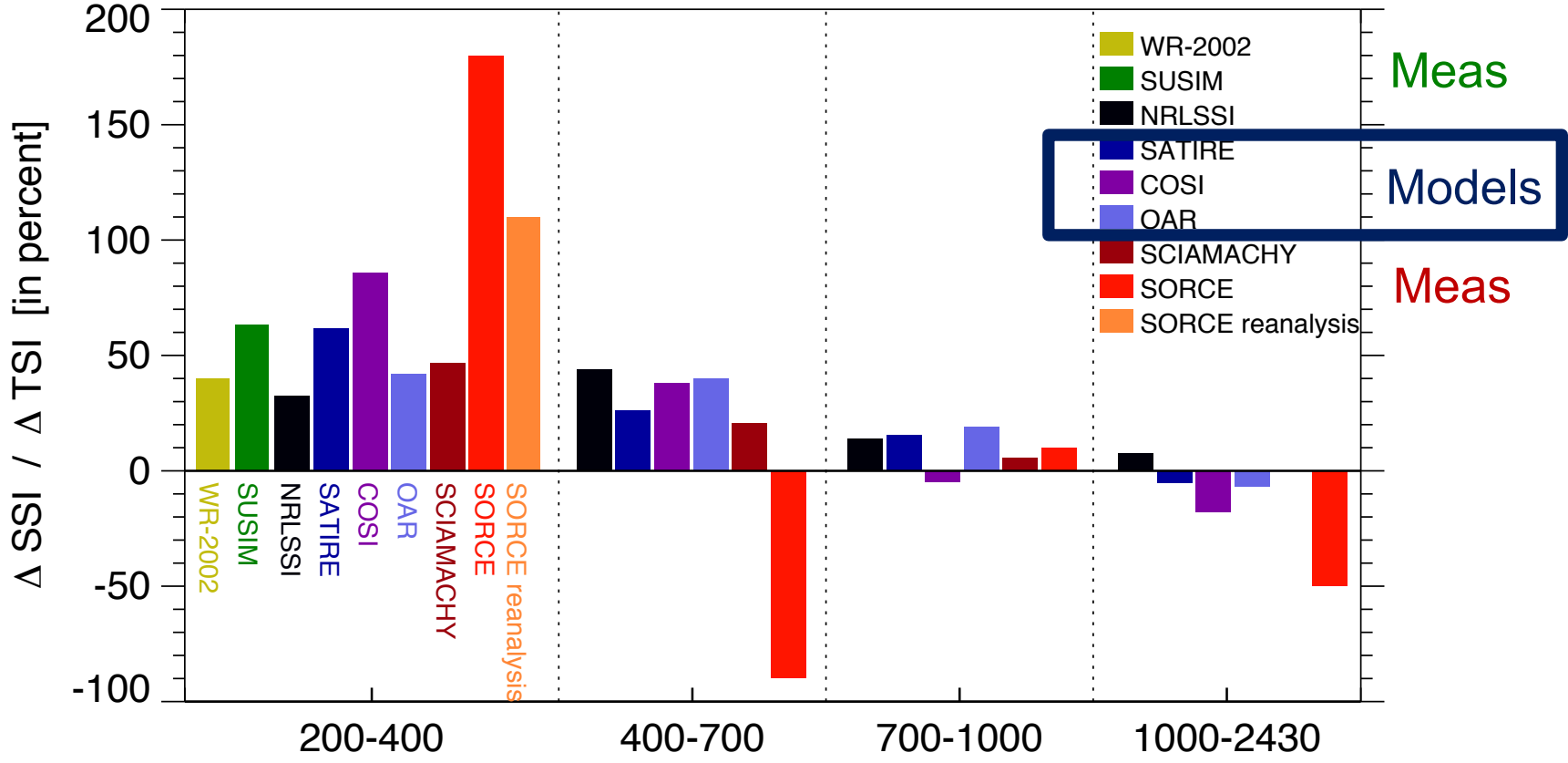
Schrijver et al. (2011)
Steinhilber et al. (2009)
Wang et al. (2005)
Krivova et al. (2010)
Shapiro et al. (2011)
Judge et al. (2012)
Svalgaard (2014)
Egorova et al. (2018)
Yeo et al. 2020
Penza et al. ESPM16 poster 5.1



Adapted from Solanki et al. 2013, ARA&A

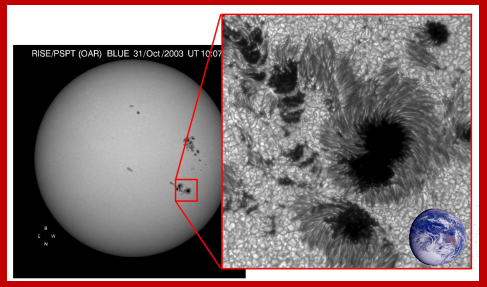
CURRENT KNOWLEDGE OF SPECTRAL SI

SSI is even more uncertain



Ermolli et al. 2013, ACP

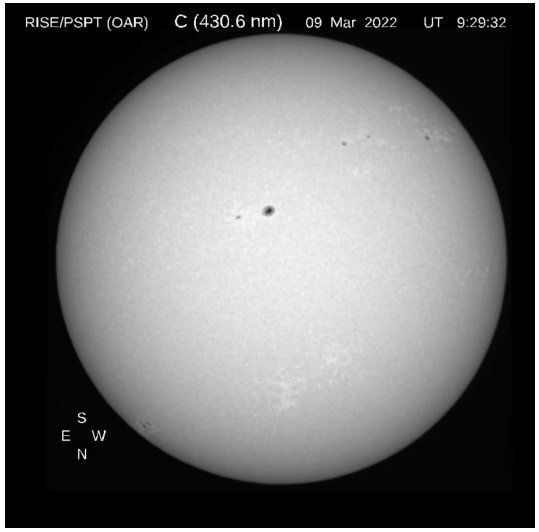
BUILDING BLOCKS

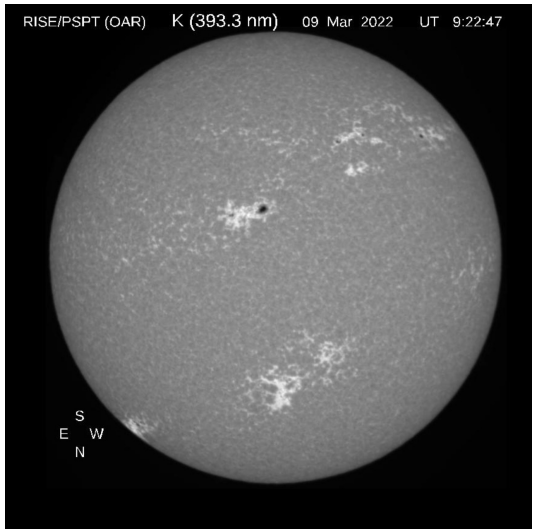


Acquisition of new observations

OBSERVATIONS

Rome/PSPT Precision Solar Photometric Telescope (1996-)



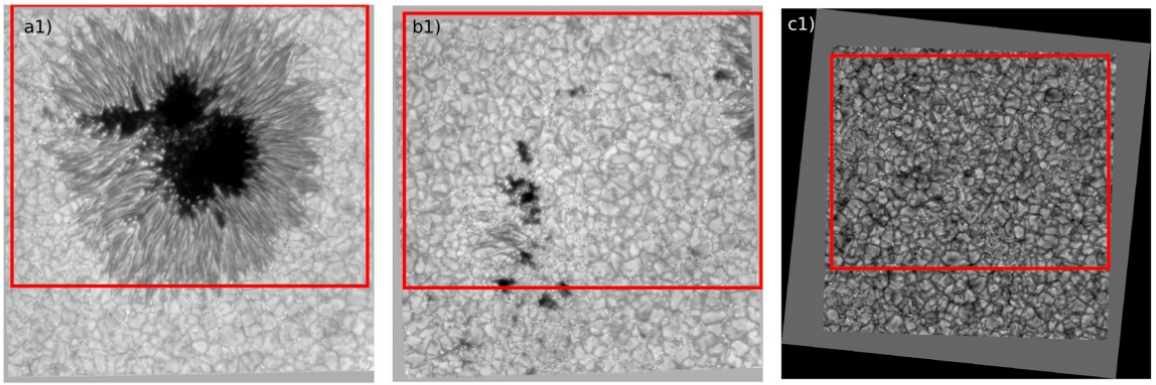


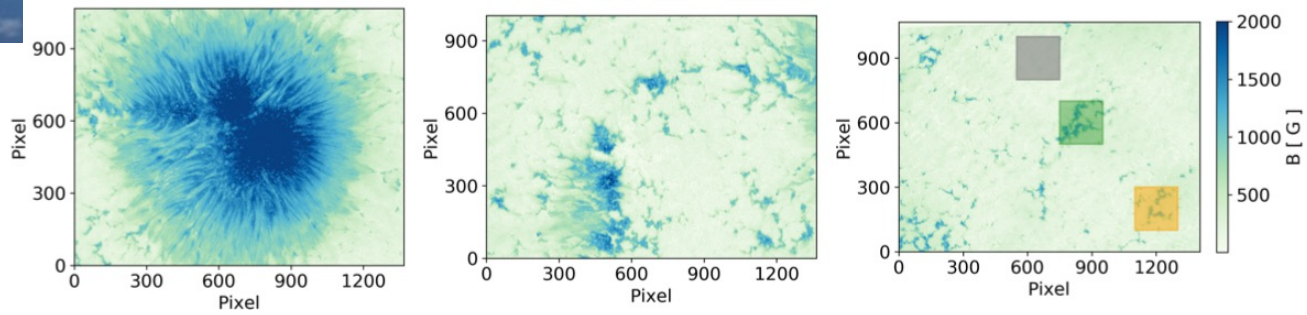
CCD camera 2kx2k
0.1% pixel photom accuracy
1 “/pixel

Ca II K 393.3 nm bw 0.25 nm
Ca II K 393.3 nm bw 0.1 nm
Blue 409.4 nm bw 0.25 nm
G-band 430.6 nm bw 1.2 nm
Red 607.2 nm bw 0.5 nm

OBSERVATIONS

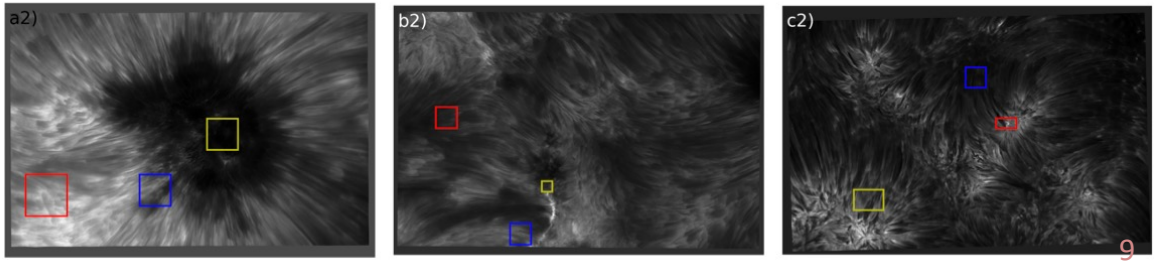
High res spectropol obs from ground- and space-based telescopes





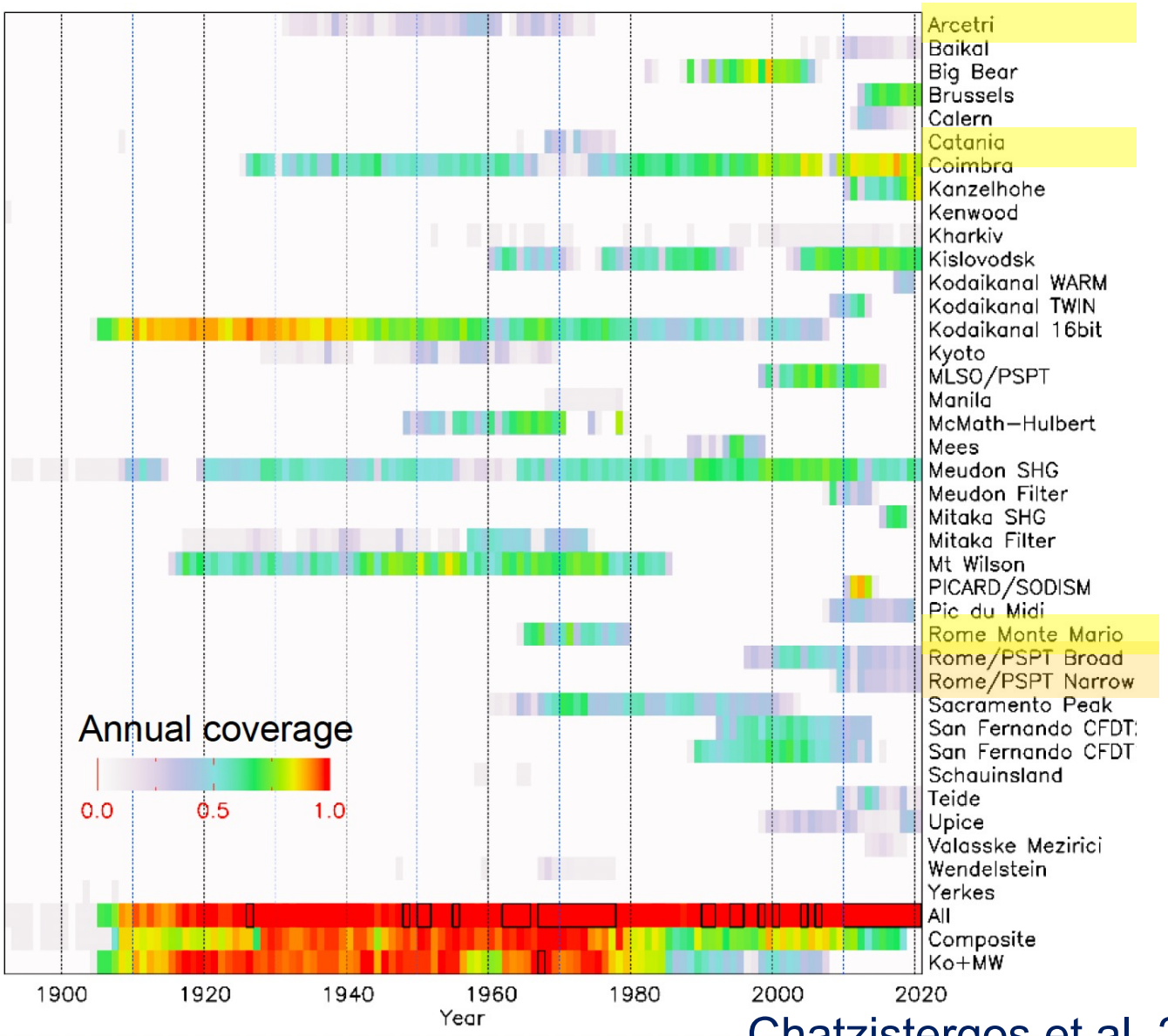
Photosphere
Fe I 630.1 nm
0.0602″/pixel

Chromosphere
Ca II K 393.3 nm
0.0376″/pixel



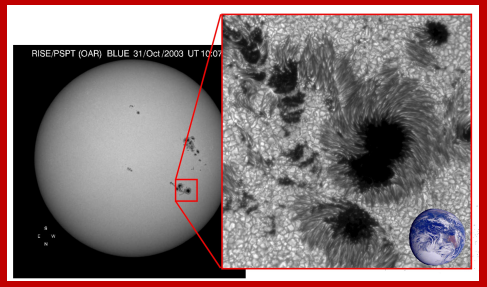
OBSERVATIONS

Modern and Historical Ca II K observations

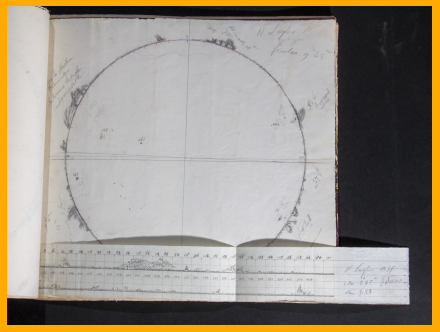


Chatzistergos et al. 2018, A&A

BUILDING BLOCKS



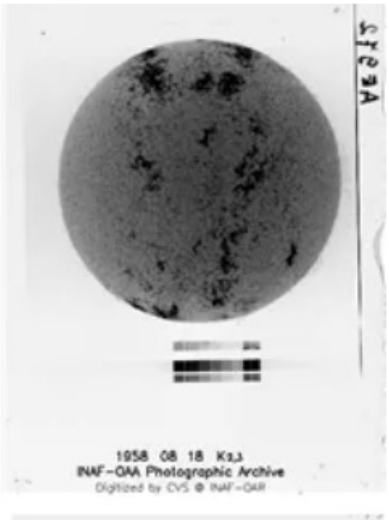
Acquisition of new observations

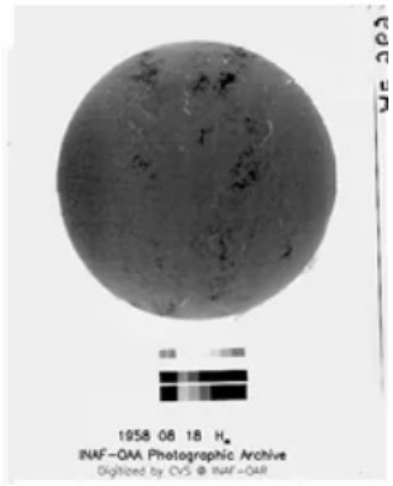


Recovery of historical data

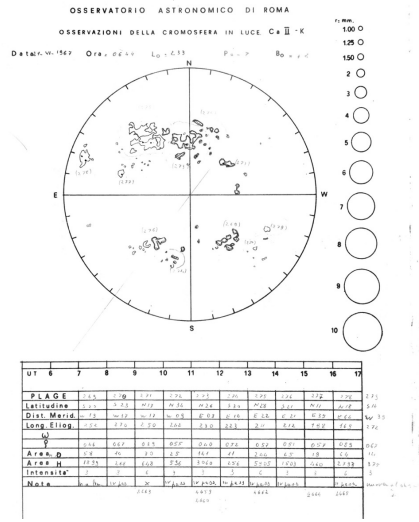
OBSERVATIONS

Digitization and exploitation of historical observations



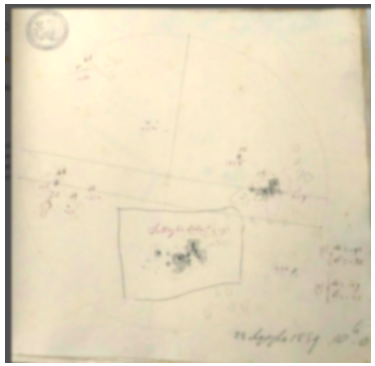


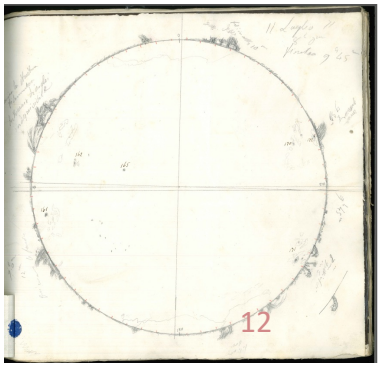
Arcetri Spectroheliograms @ OAA
1926-1974
12759 plates (Ca II K: 5250, Ha: 6941)



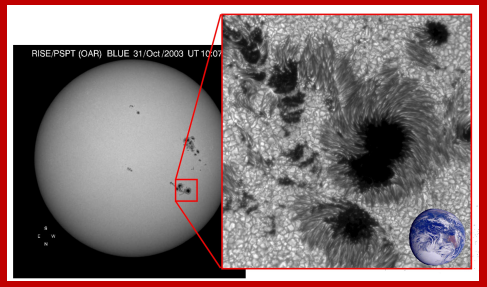
Monte Mario Equatorial Spar
filtergrams and drawings
Ca II K 1964-1979: 6177
Ca II K 1965-1981: 1566
WL+Ha 1965-1989: 1000

Collezione Angelo Secchi
drawings and manuscripts
1858-1878 (drawings: 6401, tables:1045)

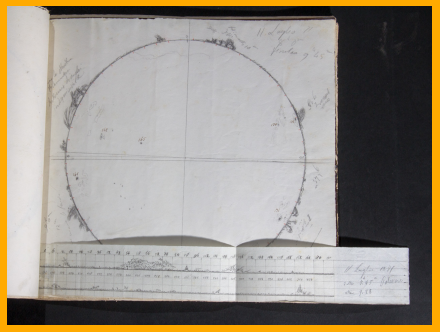




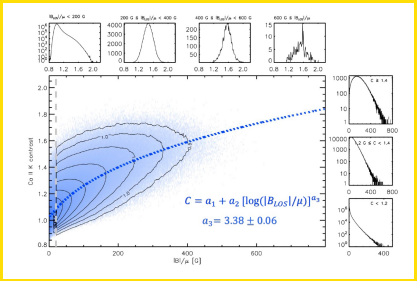
BUILDING BLOCKS



Acquisition of new observations



Recovery of historical data

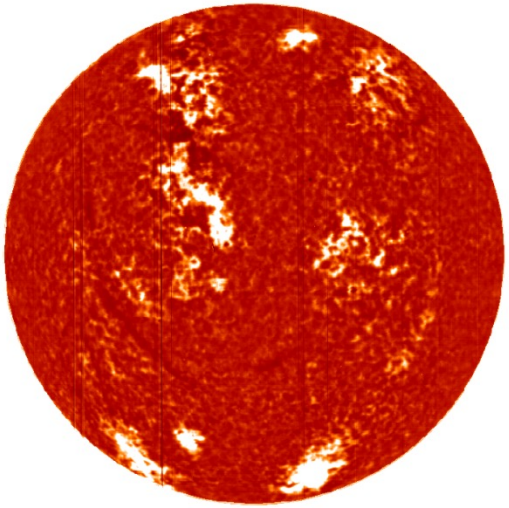


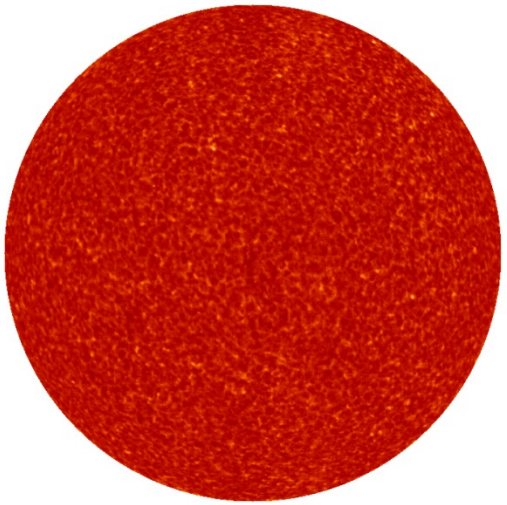
Data analysis & Models

IMAGE PROCESSING

Chatzistergos et al. 2018, A&A

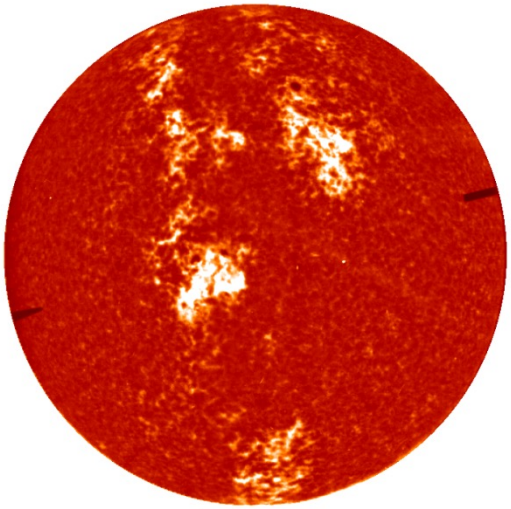
Arcetri
16/05/1957

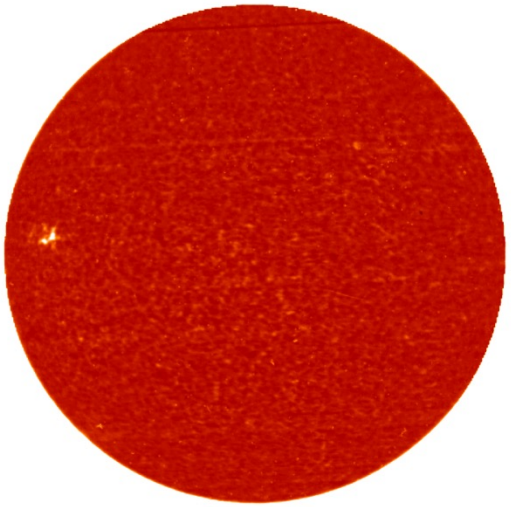




Kodaikanal
23/09/1913

Mt Wilson
04/03/1982

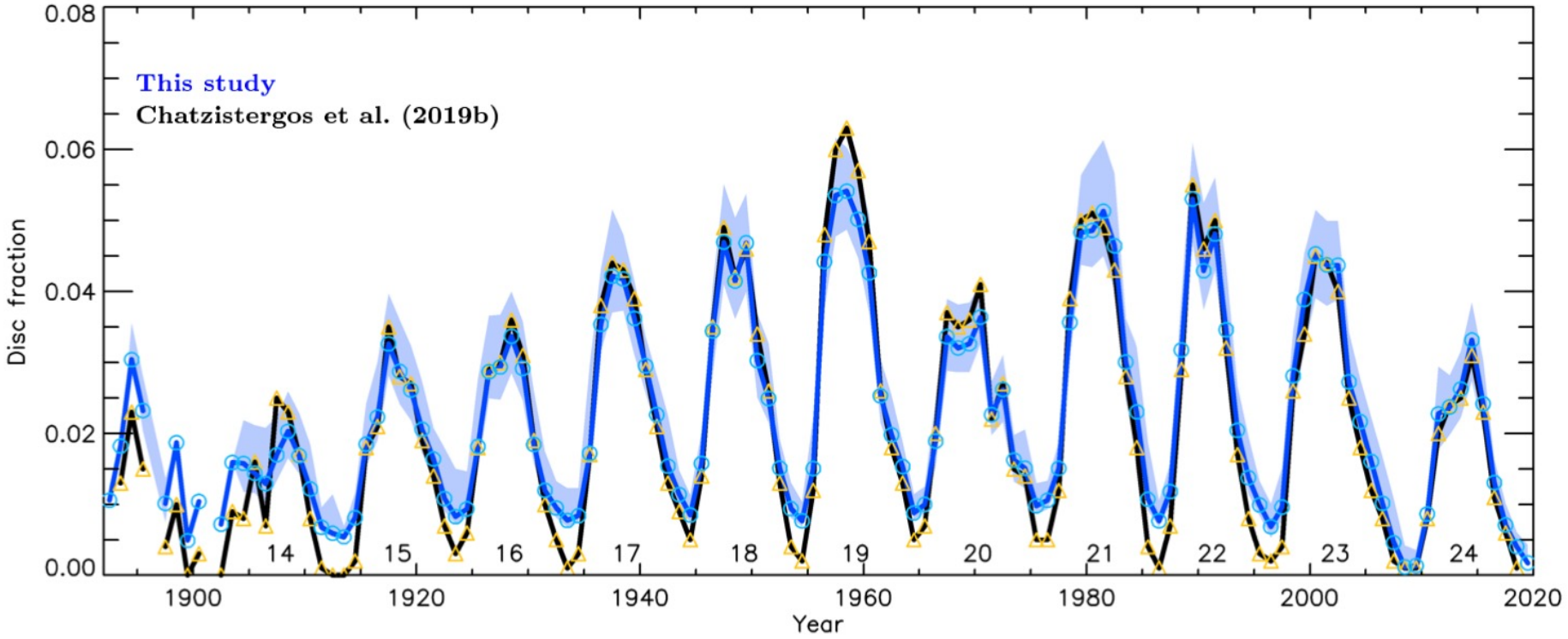




Mitaka
26/05/1964

PLAGES OVER THE 20th CENTURY

Chatzistergos et al. 2019b, 2020, A&A

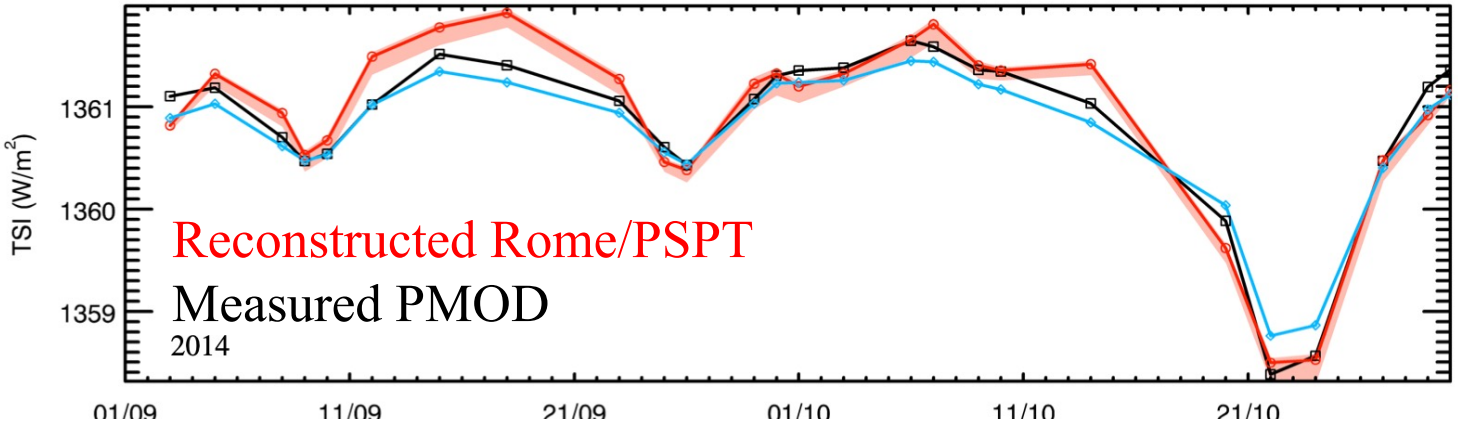


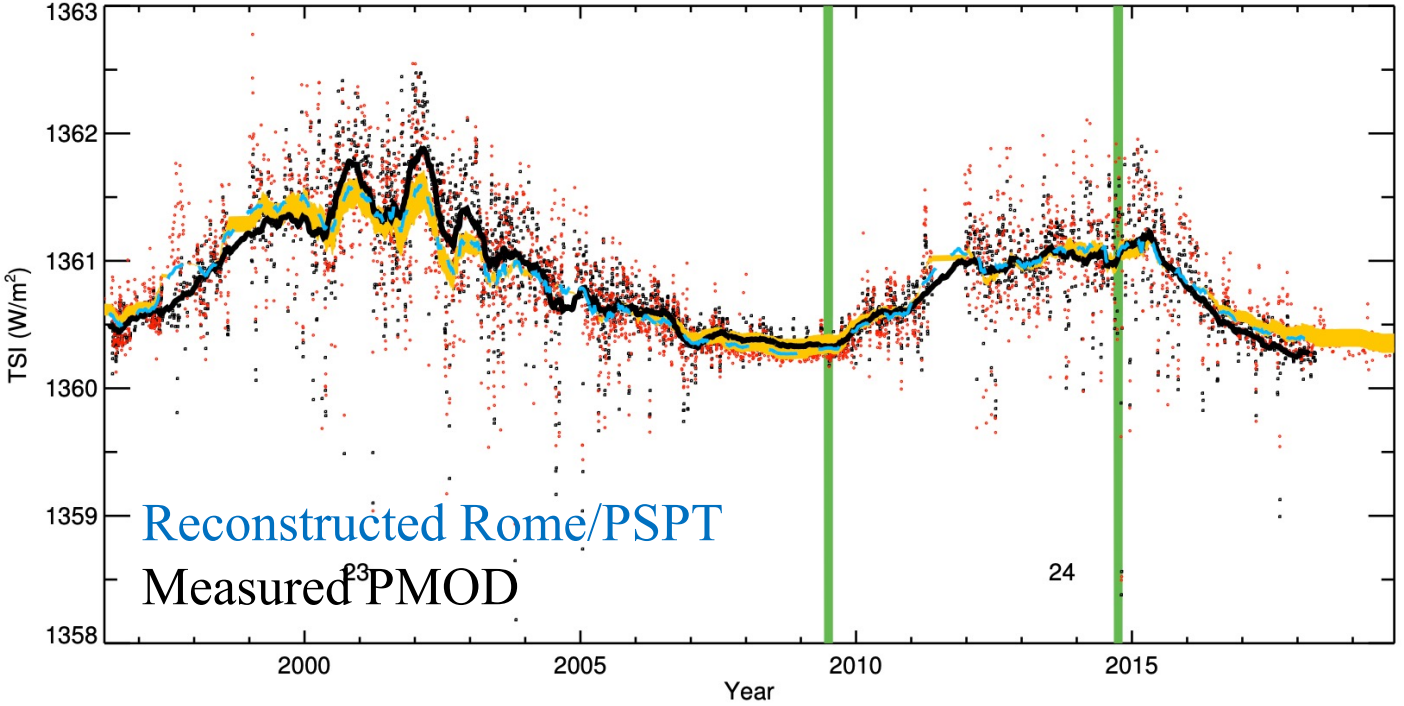
FIRST Plage Area **Composite**
>290 000 Ca II K **images** from **43 archives**
spanning **from 1892 to 2019** (12 solar cycles)

RECONSTRUCTING SOLAR IRRADIANCE

From modern and historical observations

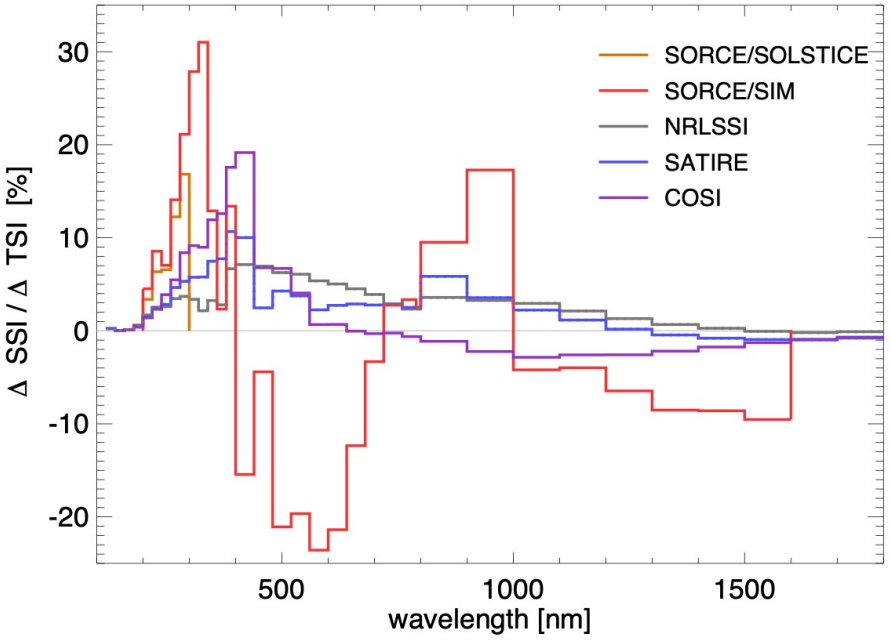
Chatzistergos et al. 2021, A&A





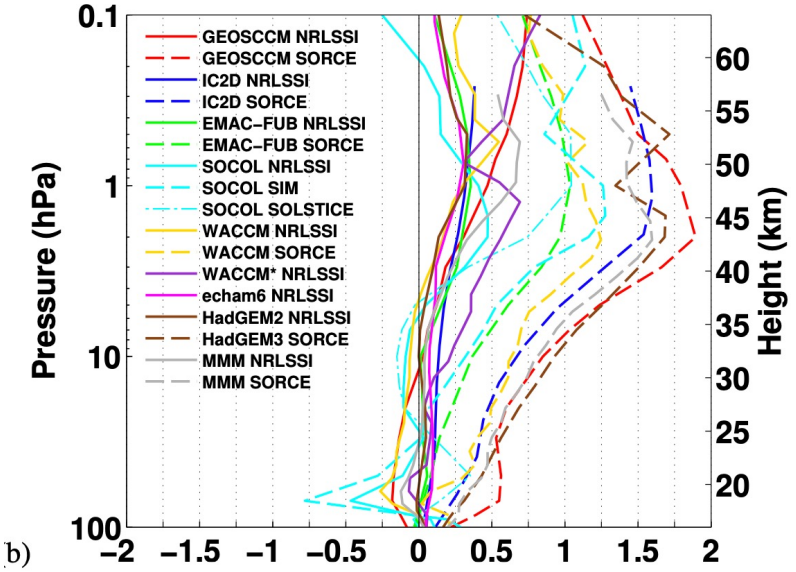
APPLICATION TO EARTH'S CLIMATE STUDIES

Spectral Solar Irradiance Max-Min



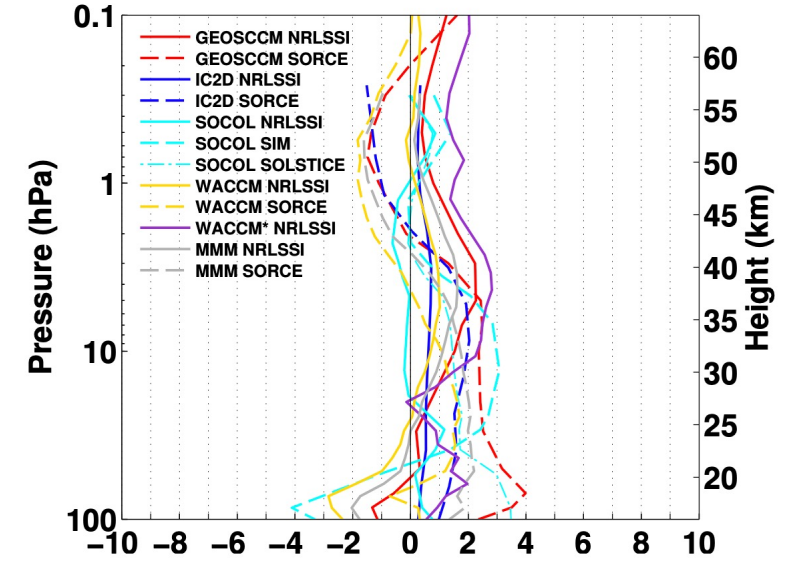
Ermolli et al. 2013, ACP

Earth's Atm Temperature (K/day)



b)

Earth's Atm Ozone (%)



WORK OUTCOMES

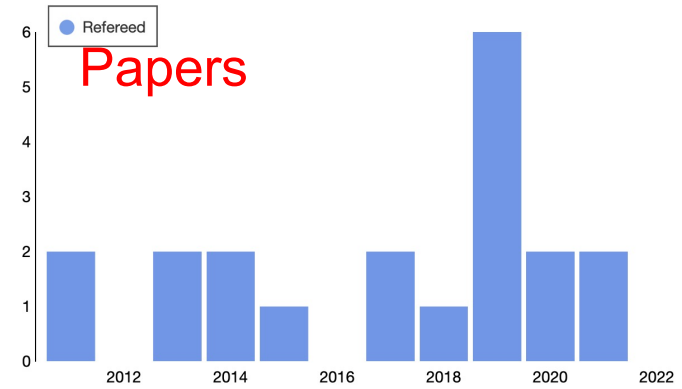
Source:ADS

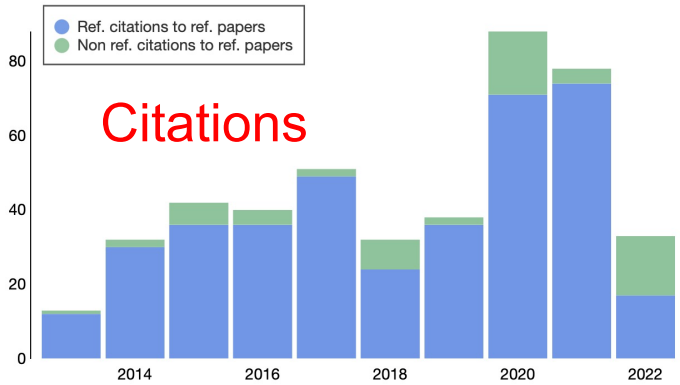
DATA

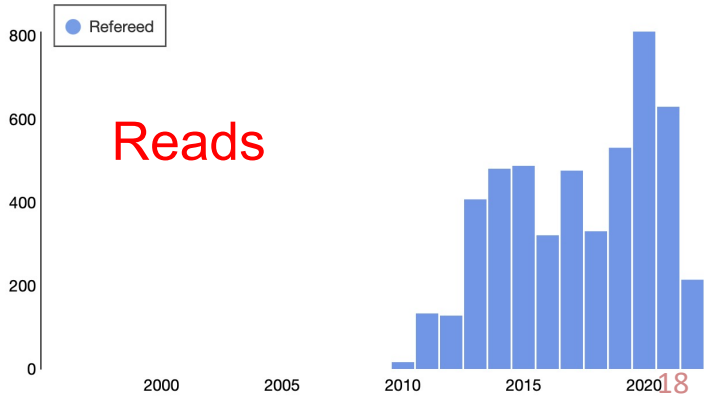
http://www.oa-roma.inaf.it/fisica-solare/

PAPERS

- Criscuoli et al. 2011, 2011ApJ...728...92C
- Ermolli et al. 2012, 2011CoSka..41...73E
- Romano et al. 2012, 2012SoPh..280..407R
- Criscuoli et al. 2013, 2013ApJ...763..144C
- Ermolli et al. 2013, 2013ACP....13.3945E
- Ermolli et al. 2014, 2014SSRv..186..105E
- Ermolli et al. 2014, 2014SoPh..289.2525E
- Giorgi et al. 2015, 2015SoPh..290..507G
- Stangalini et al. 2017, 2017JSWSC...7A...5S
- Cristaldi et al. 2017, 2017ApJ...841..115C
- Piersanti et al. 2017, 2017SoPh..292..169P
- Chatzistergos et al. 2018, 2018A&A...609A..92C
- Chatzistergos et al. 2019, 2019NCimC..42....5C
- Chatzistergos et al. 2019, 2019A&A...625A..69C
- Chatzistergos et al. 2019, 2019A&A...626A.114C
- Chatzistergos et al. 2019, 2019SoPh..294..145C
- Hayakawa et al. 2020, 2019SpWea..17.1553H
- Chatzistergos et al. 2020, 2020A&A...639A..88C
- Chatzistergos et al. 2020, 2020JSWSC..10...45C
- Chatzistergos et al. 2021, 2021A&A...656A.104C
- Carrasco et al. 2021, 2021JSWSC..11...51C

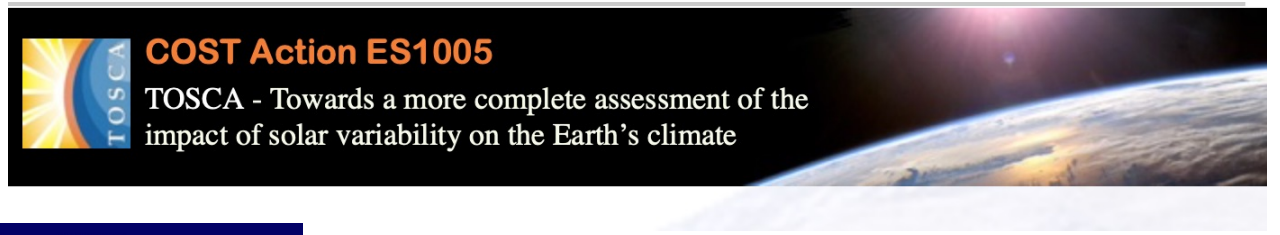


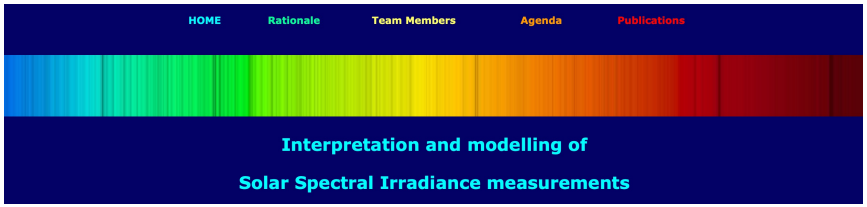




LEADERSHIP


INTERNATIONAL SPACE SCIENCE INSTITUTE
International Team


TOSCA
COST Action ES1005
TOSCA - Towards a more complete assessment of the impact of solar variability on the Earth's climate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Rationale
Team Members
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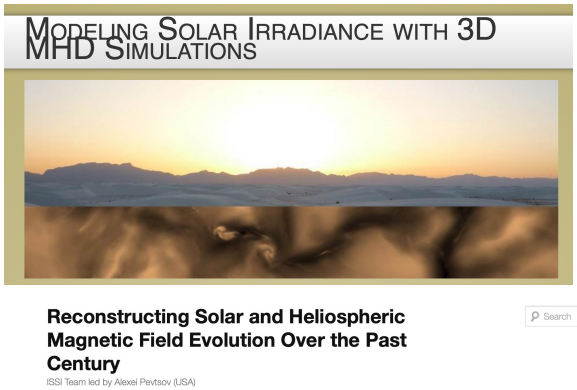
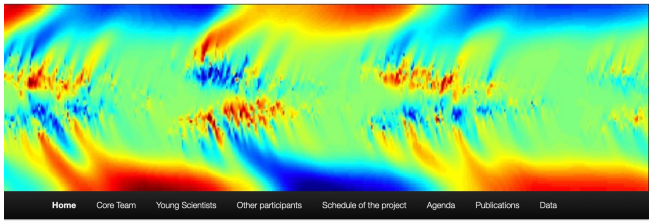
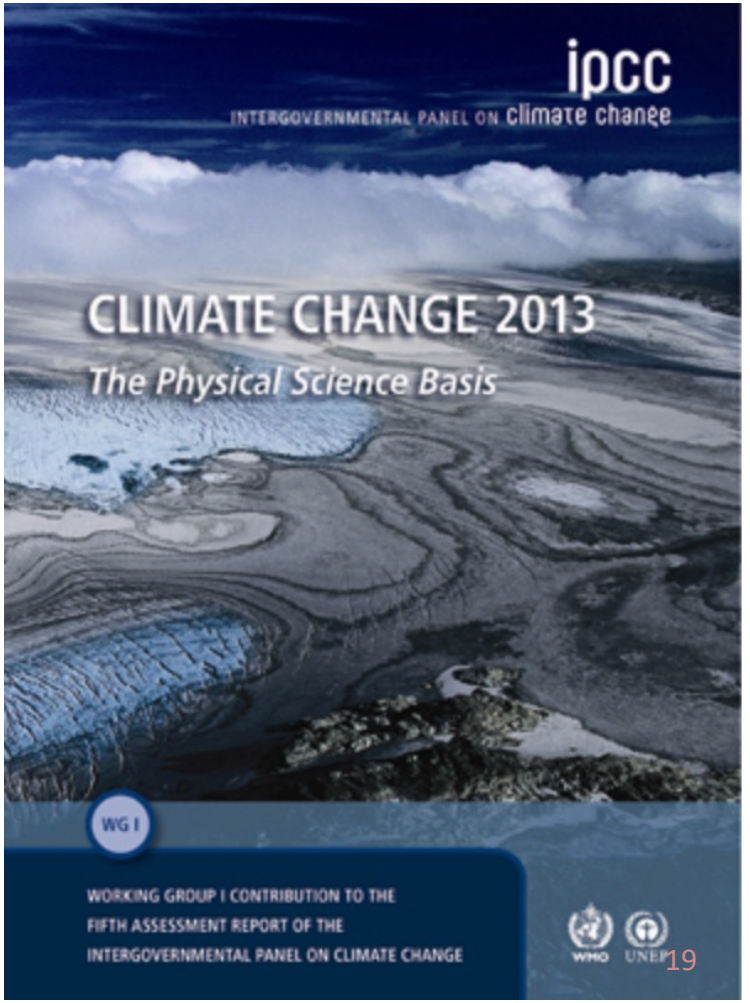
Interpretation and modelling of
Solar Spectral Irradiance measurements


MODELING SOLAR IRRADIANCE WITH 3D MHD SIMULATIONS
Reconstructing Solar and Heliospheric Magnetic Field Evolution Over the Past Century
ISSI Team led by Alexei Pevtsov (USA)
Search


Home
Core Team
Young Scientists
Other participants
Schedule of the project
Agenda
Publications
Data

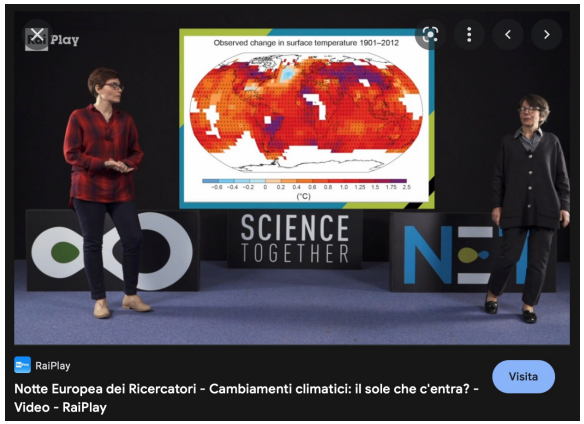

Modeling Space Weather And Total Solar Irradiance Over The Past Century
ISSI Team led by Alexei Pevtsov (USA)
Search


ipcc
INTERGOVERNMENTAL PANEL ON climate change
CLIMATE CHANGE 2013
The Physical Science Basis
WG I
WORKING GROUP I CONTRIBUTION TO THE
FIFTH ASSESSMENT REPORT OF THE
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO
UNEP

EXPOSURE

RAI QUARK, TGR, TG2, ANSA - 2005

FESTIVAL DELLA SCIENZA GENOVA



RAI CULTURA NAUTILUS
Tutta l'energia del Sole – 2019

RAI PLAY ERN
Cambiamenti climatici – 2019

FOCUS JUNIOR - 2021

TEAM

FTE INAF 1.6 (1.3 TI) + 0.6

Massimo Fofi (retired 2005)
Carla Bernacchia (1996-1998)
Mauro Centrone (1999-2009)
Cinzia Fazzari (2000-2002)
Elena Marchei (2003-2005)
Valentina Penza (2003-2005)
Corrado Perna (2003-2005)
Matthieu Kretzschmar (2005)
Lidia Contarino (postdoc, 2009)
Serena Criscuoli (2002, 2007-2012)
Marco Stangalini (2012-2018)
Wera di Cianni (2016)
Alice Cristaldi (2014-2017)
Mariachiara Falco (2016)
Fabio Giannattasio (2017)
Cosmin Constantin Puiu (2018)
Theodosios Chatzistergos (2017-2020)
Mariarita Murabito (2017-2021)
Catello Leonardo Matonti (2021-2022)

Max Planck Instute Solar System Research, Goettingen, Germany
Leibniz Institute for Solar Physics, Freiburg, Germany
Universidad de Extremadura, Badajoz, Spain
Nagoya University, Japan
INAF Osservatorio Astrofisico di Catania
Università Sapienza

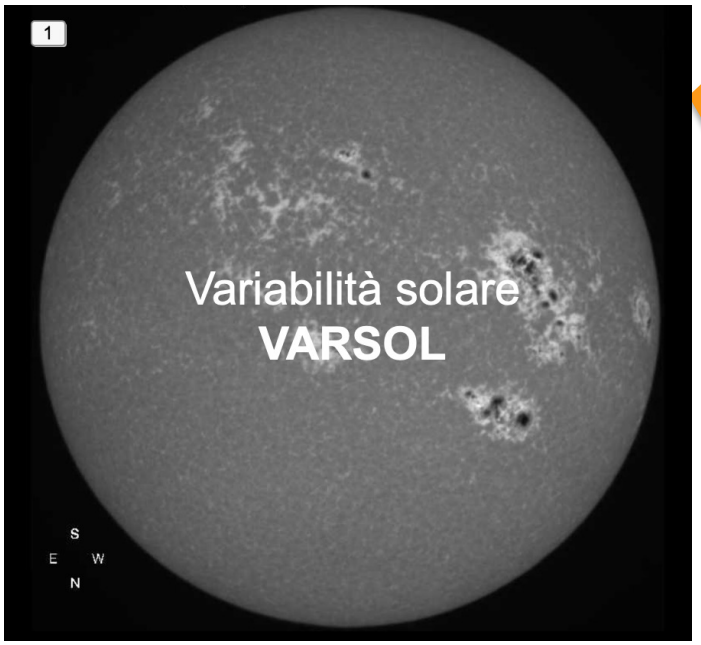
FUNDS

1995-2022

Total acquired: 700 kEuro

- Ministero dell'Ambiente (1995, 1996)
- Regione Lazio (2003-2005)
- PRIN-MIUR (1998, 2000, 2002, 2004)
- ASI-ESS (2008-2010)
- FP7 eHEROES (2011-2014)
- FP7-SOLID (2011-2014)
- FP7 SOLARNET (2013-2017)
- H2020 SOLARNET (2019-2022)

PROBLEMS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Variabilità solare
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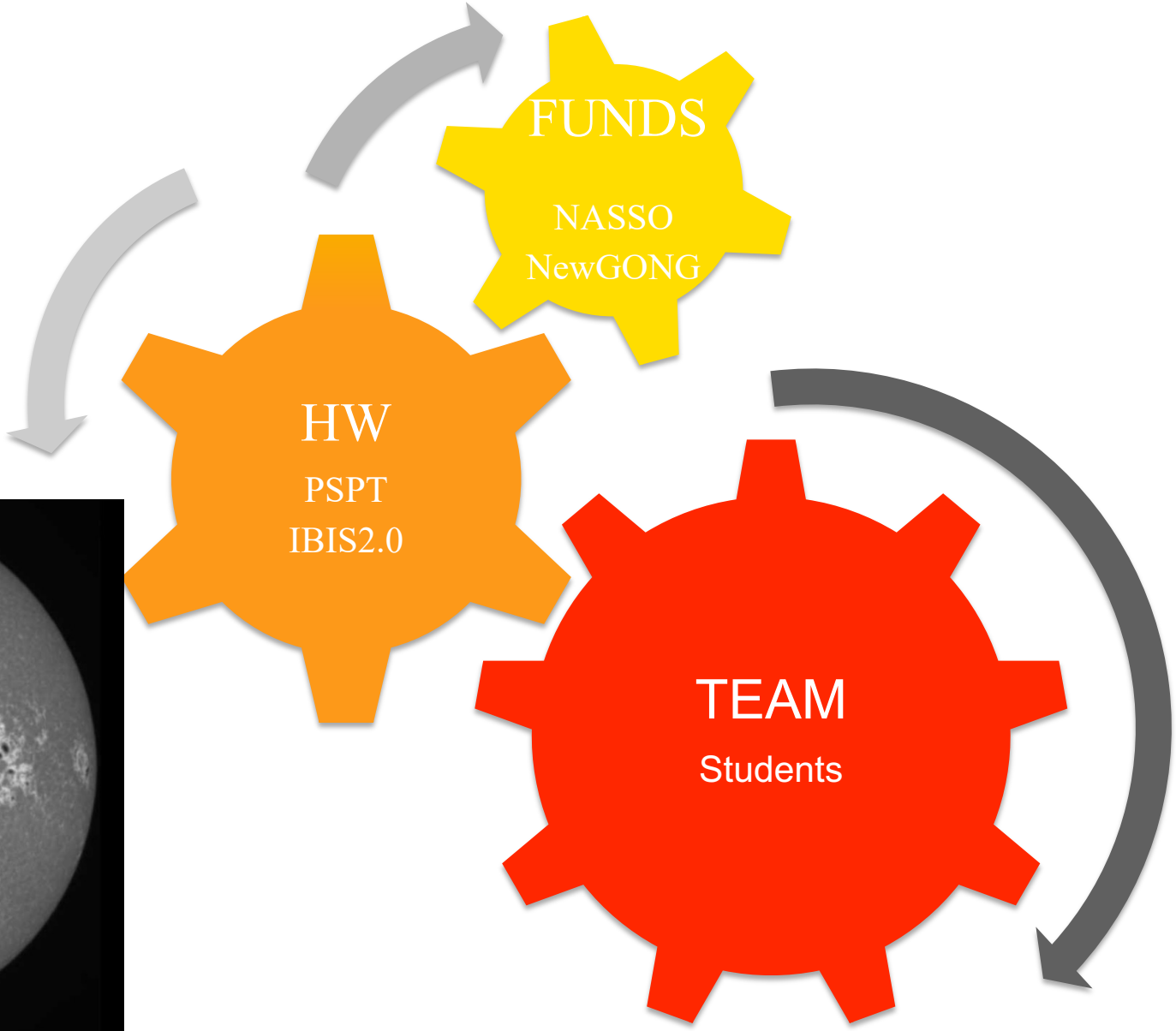
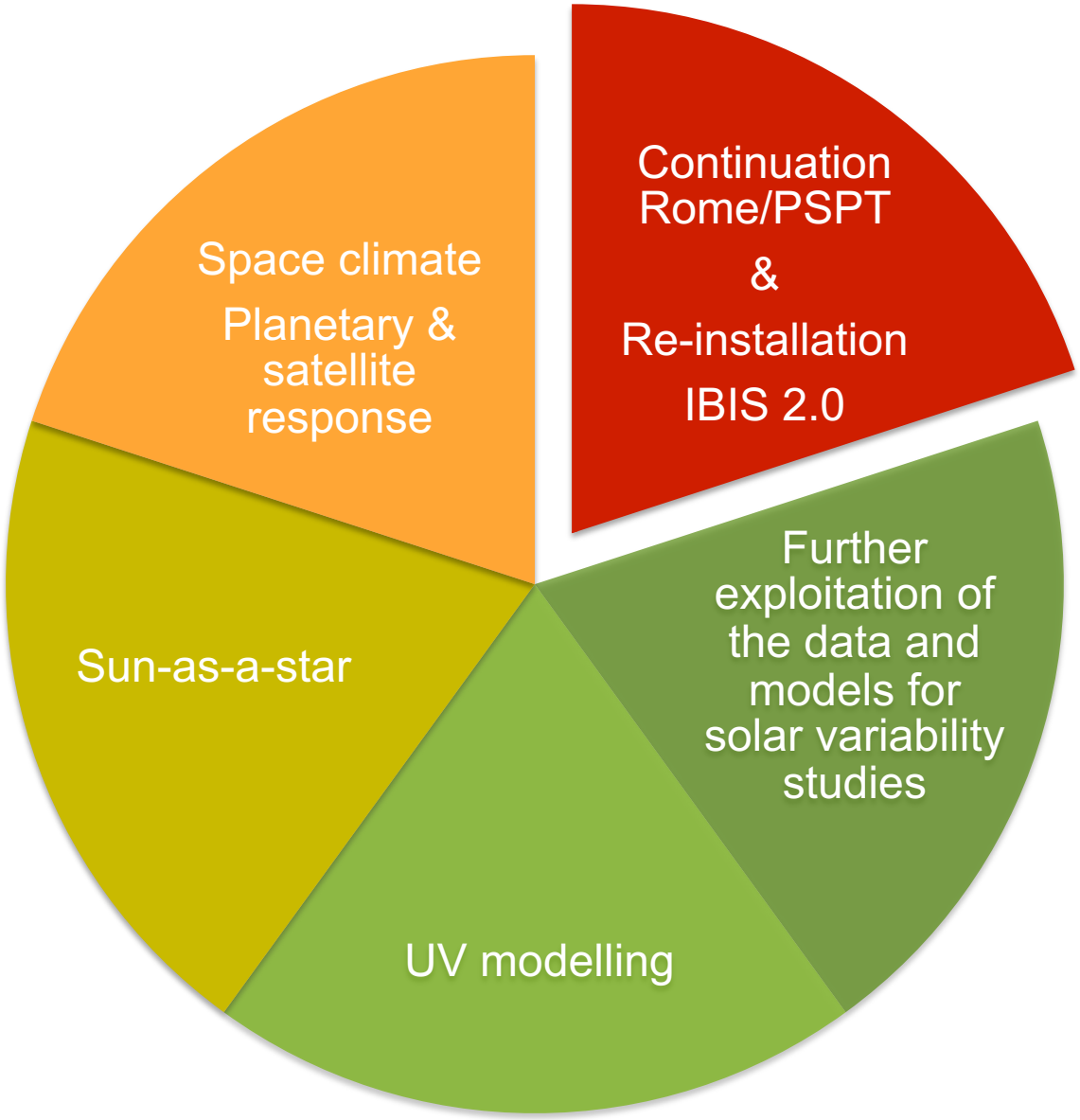
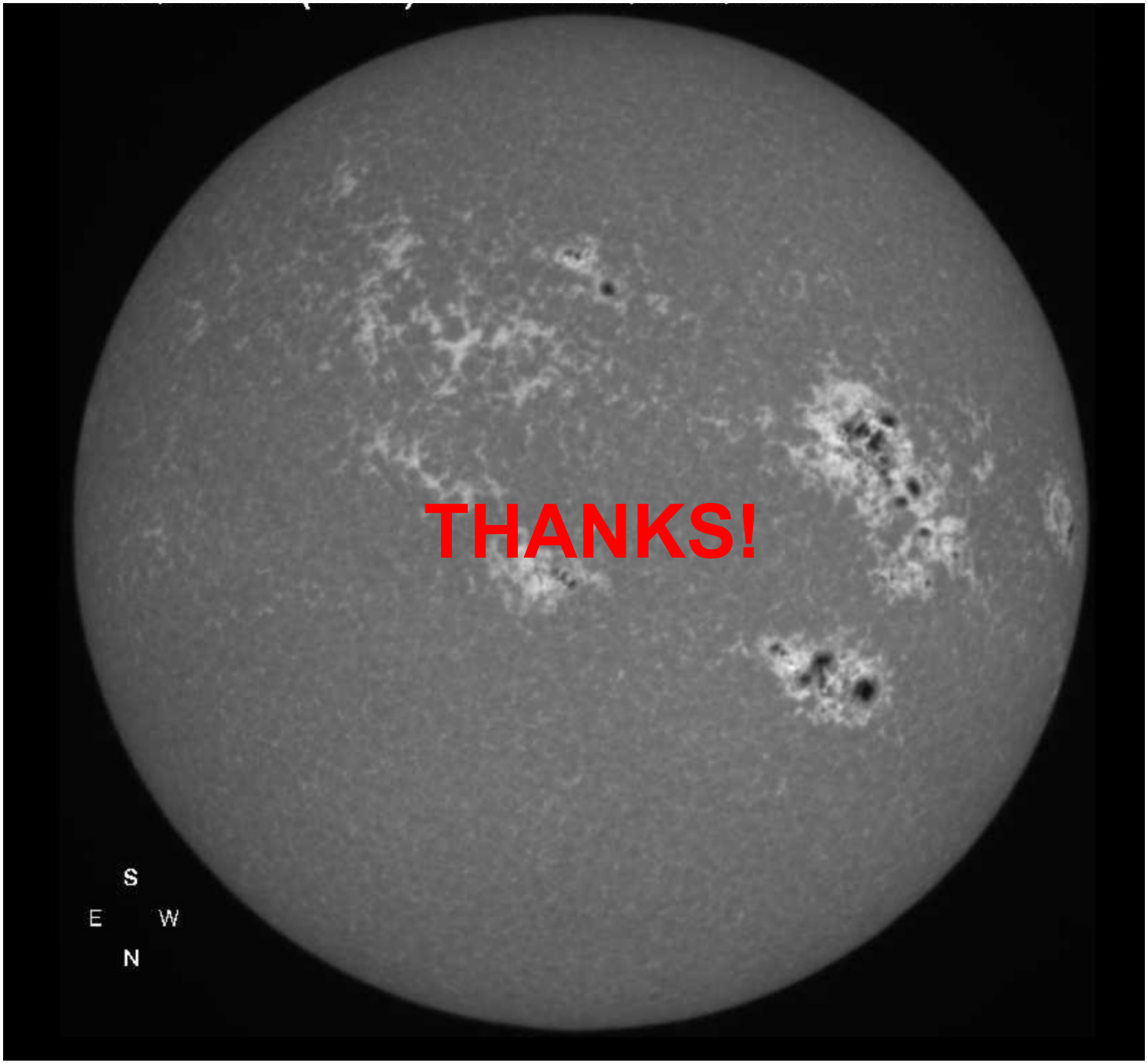

FUNDS
NASSO
NewGONG
HW
PSPT
IBIS2.0
TEAM
Students

FUTURE STEPS




THANKS!
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