WHPI Observing Campaigns

https://whpi.hao.ucar.edu/whpi_campaigns.php

Time periods of general interest when focused coordinated observations are taken
Provide common intervals for model-data comparisons and collaborative investigations

CAMPAIGN PERIODS:

Recurrent Coronal Holes/High Speed Solar Wind Streams Campaign, Mar 12 - Apr 8 2019

Total Solar Eclipse Campaign, Jun 29 - Jul 26, 2019

PARKER SOLAR PROBE CAMPAIGNS:

Parker Solar Probe 4th Perihelion Campaign, Jan 15 - Feb 11, 2020

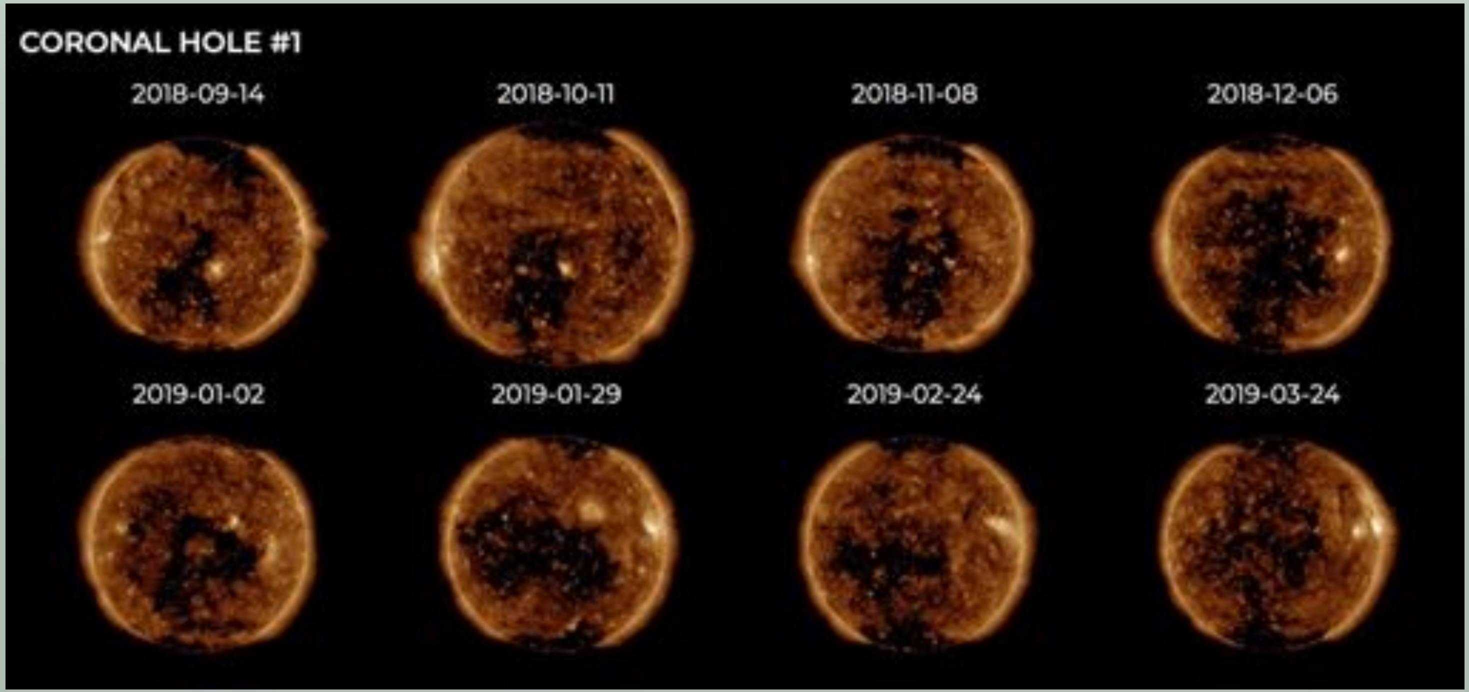
Parker Solar Probe 7th Perihelion Campaign, Jan 12 - 23, 2021

Parker Solar Probe 8th Perihelion Campaign, Apr 28 - May 7, 2021

WHPI Observing Campaigns

Recurrent Coronal Holes/High Speed Solar Wind Streams Campaign

Mar 12 - Apr 8 2019, CR 2215



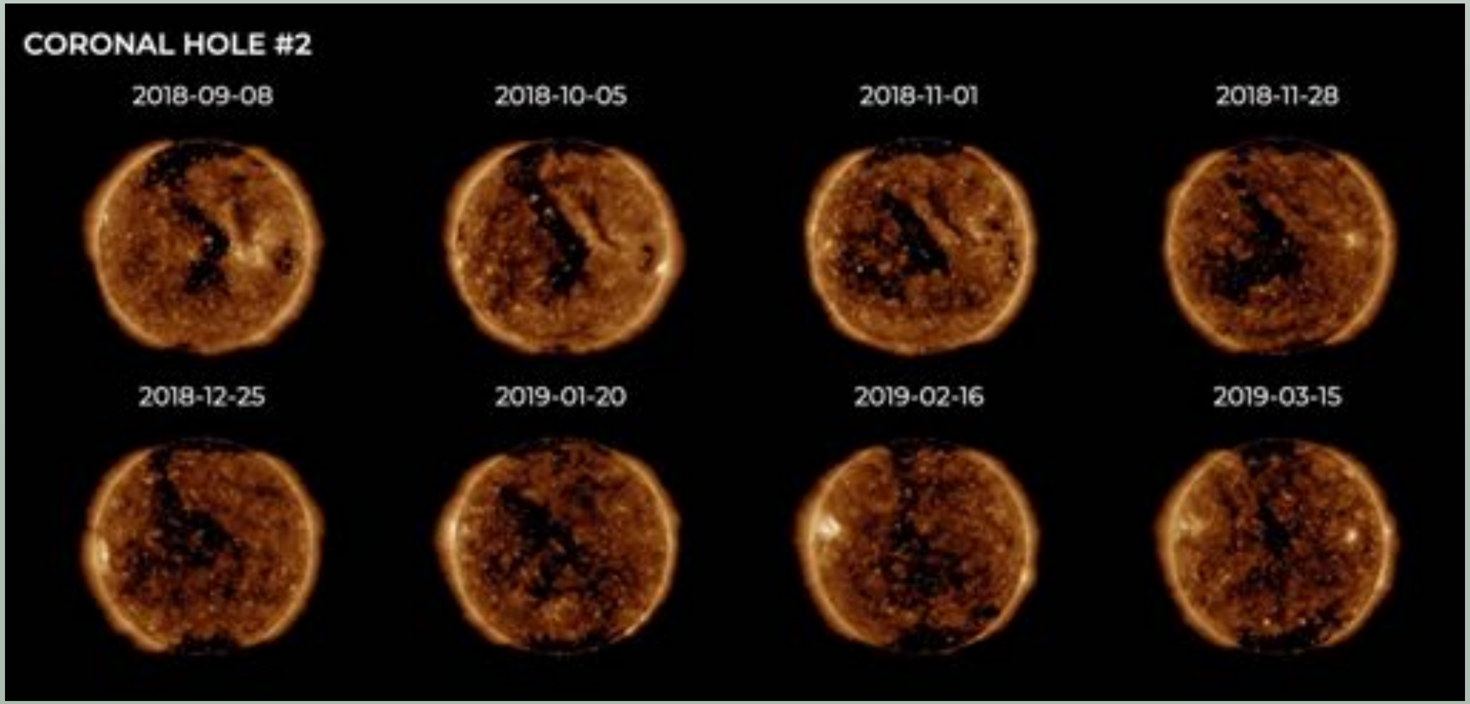
Coronal holes and the associated solar wind streams are common during the descending and minimum phase of the solar cycle

2 very long lived low-latitude coronal holes visible on the Sun for many rotations from mid 2018 to April 2019

WHPI Observing Campaigns

Recurrent Coronal Holes/High Speed Solar Wind Streams Campaign

Mar 12 - Apr 8 2019, CR 2215



Coronal holes and the associated solar wind streams are common during the descending and minimum phase of the solar cycle

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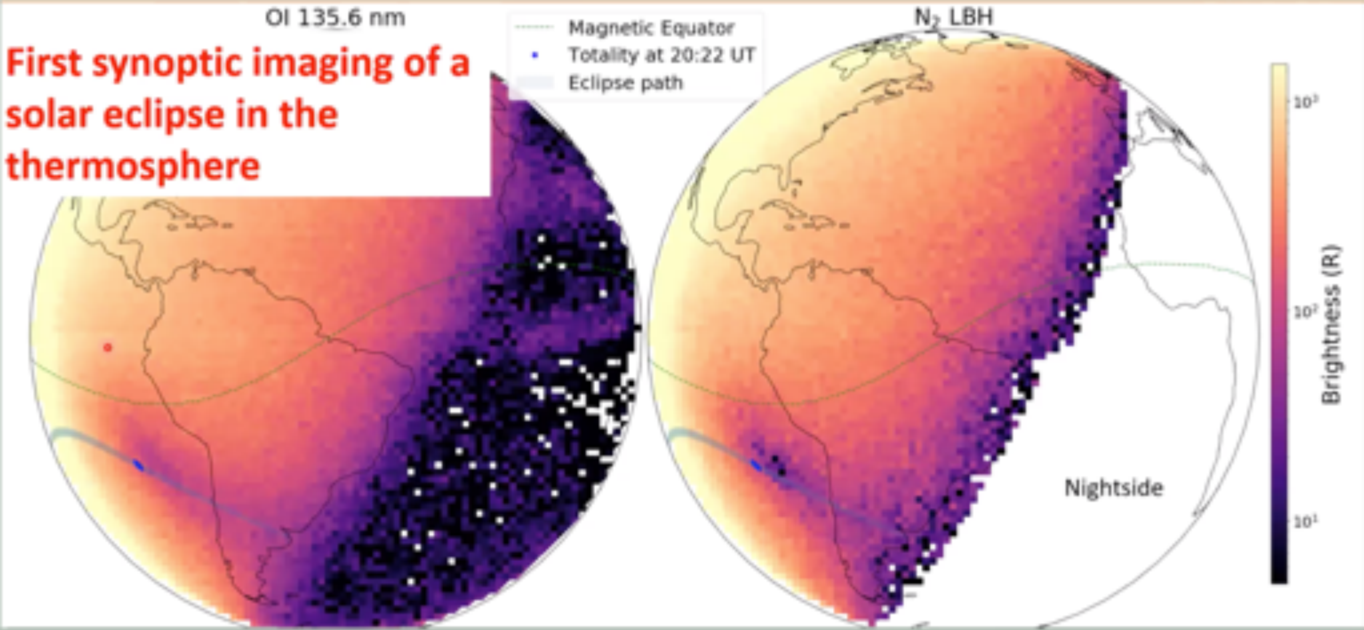
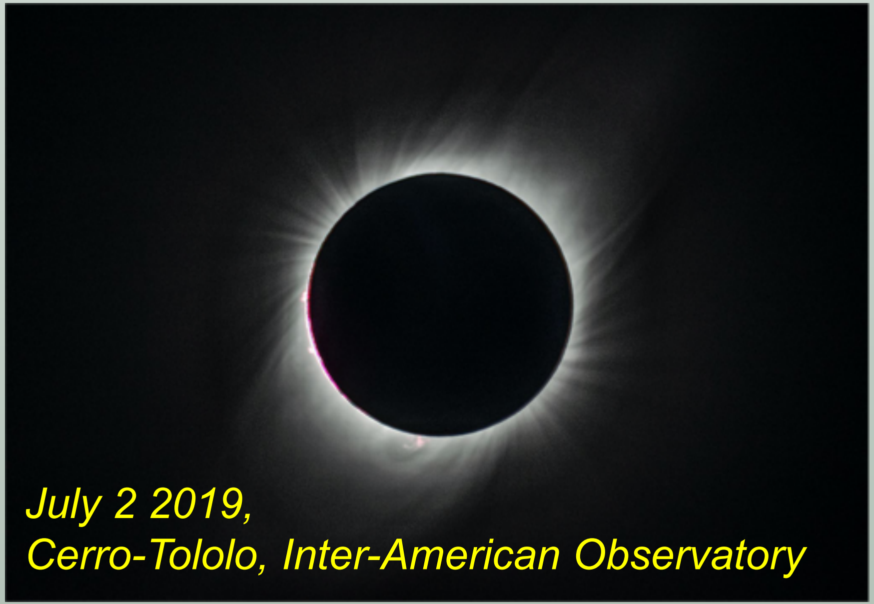
WHPI Observing Campaigns

Total Solar Eclipse Campaign

Jun 29 - Jul 26, 2019



Courtesy Saurav Aryal and GOLD team



July 2 2019,
Cerro-Tololo, Inter-American Observatory

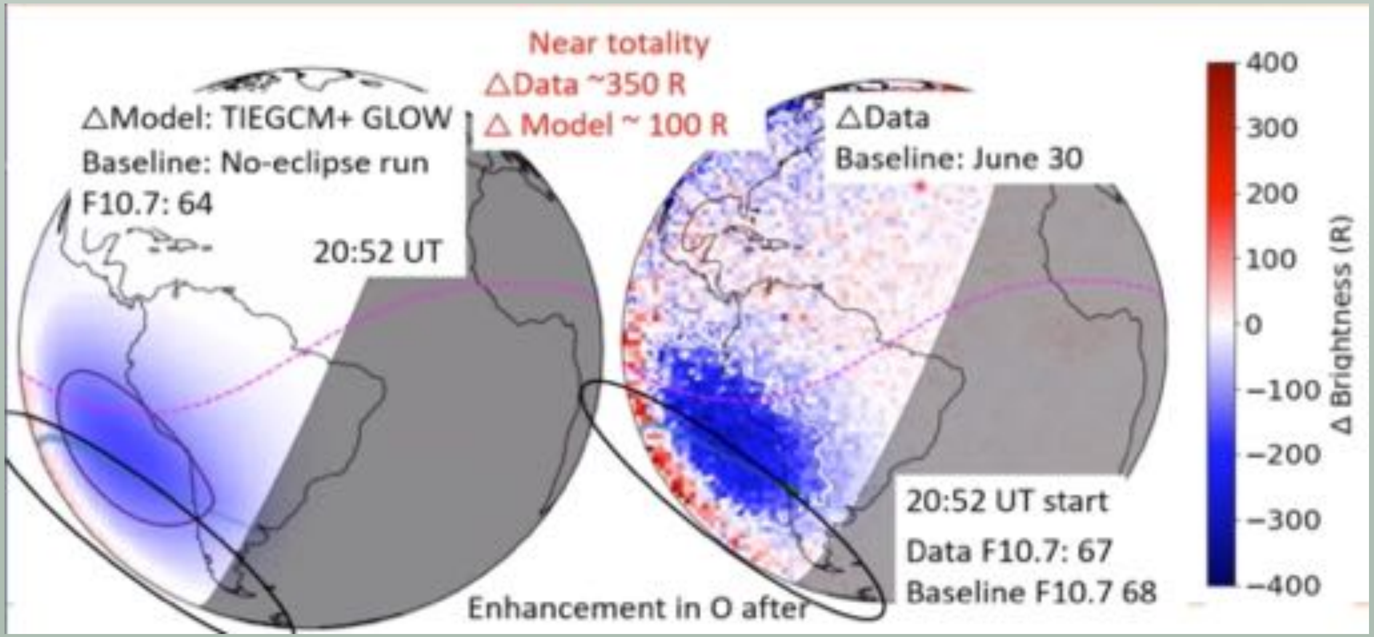
Solar eclipses are rare opportunities to observe the low corona

All solar telescopes involved
Joined by geospace observatories, including the GOLD satellite

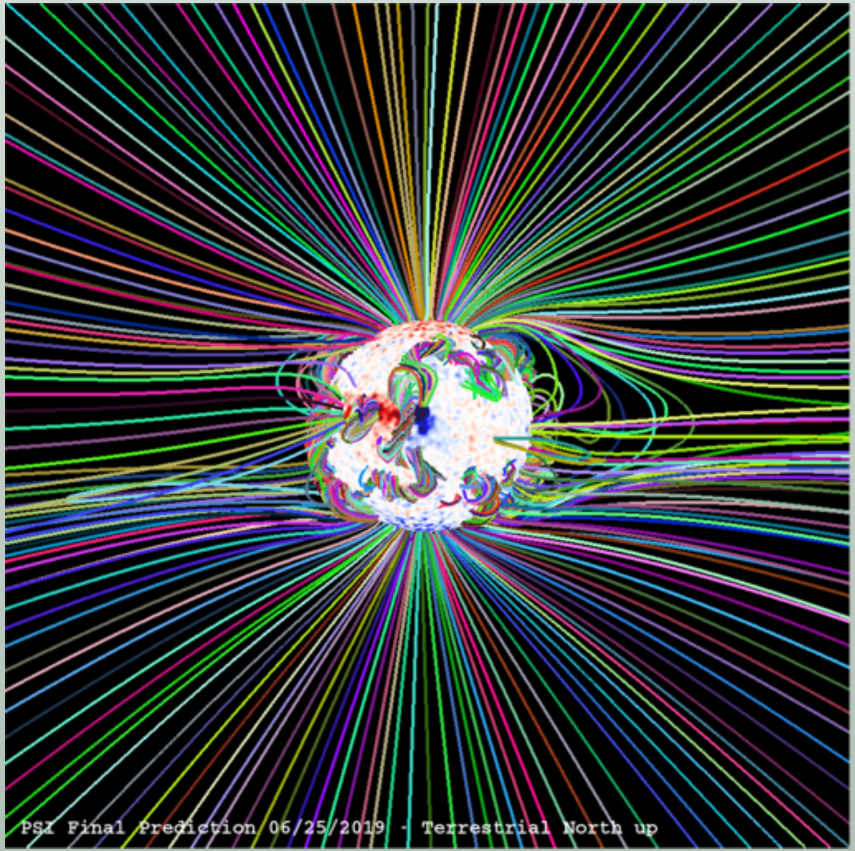
WHPI Observing

Total Solar Eclipse Campaign

Jun 29 - Jul 26, 2019



Courtesy Saurav Aryal and GOLD team



MHD Model of the solar corona from PSI (66 million grid points!)

Extensive modeling effort:
Solar models &
Upper atmospheric models

WHPI Observing Campaigns

PSP PERIHELION CAMPAIGNS

4th PSP Perihelion **Jan 15 - Feb 11, 2020**

7th PSP Perihelion **Jan 12 - 23, 2021**

(Nour Raouafi PI)

Unique opportunity for coordinated observations. PSP nearly radially aligned with the Earth and several satellites

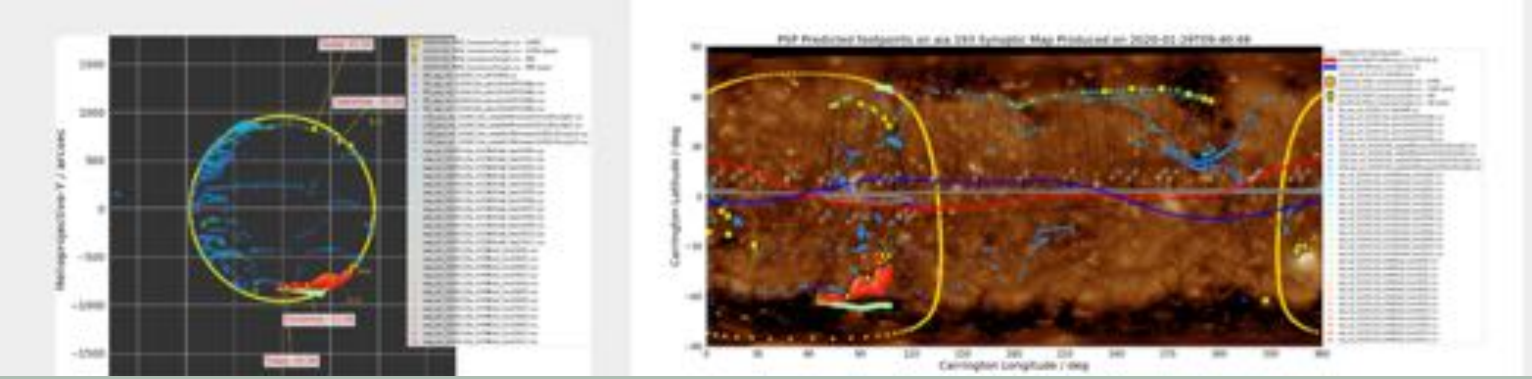
8th PSP Perihelion **Apr 28 - May 7, 2021**

(Stefan Hofmeister PI)

Focused on high resolution observations of coronal holes. Many large solar telescopes involved: GREGOR, SST, BBSO, DST, and many radio observatories

WHPI Observing Campaigns

WHPI coordinated activities ahead of the campaigns:
network of ~40 ground-based observatories around the world
7 heliospheric, 15 geospace, and 3 planetary space missions
~600 participants



Target information were posted on the WHPI webpage, based on the prediction of the modeling teams lead by P. Riley and S. Badman

Thank you to all the observatories in space and on the ground and to all the modelers that joined the WHPI campaigns !!

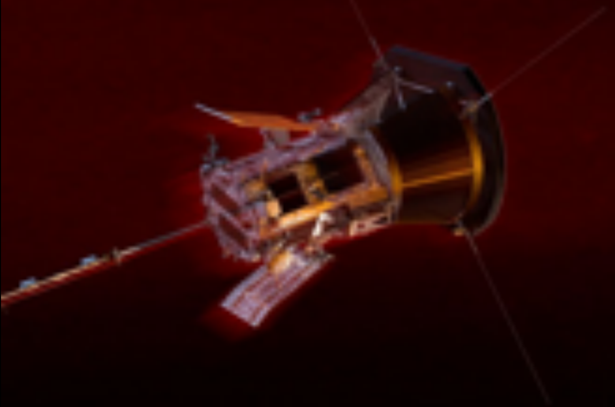
WHPI Supporting Observatories

- Advanced Modular Incoherent Scatter Radar (AMISR)
- Arecibo Observatory
- Baikal Astrophysical Observatory (BAO)
- Big Bear Solar Observatory (BBSO)
- Catania Astrophysical Observatory (INAF-OACT)
- Crimean Astrophysical Observatory (CrAO)
- Dunn Solar Telescope
- Expanded Owens Valley Solar Array (EOVSA)
- Expanded Very Large Array (EVLA)
- Félix Aguilar Observatory
- Fuxian Solar Observatory (FSO)
- Global Oscillation Network Group (GONG)
- GREGOR
- Ground Magnetometers (USGS, SuperMAG Databases)
- Hida Observatory
- Huairou Solar Observing Station (HSOS)
- Hvar Observatory
- Istituto Ricerche Solari Locarno (IRSOL)
- Jicamarca Radio Observatory (JRO)
- Kanzelhöhe Observatory (KSO)
- Kislovodsk Mountain Astronomical Station (KMAS)
- Latin American Giant Observatory/NEWRUS
- Lomnicky Stit Observatory
- Long Wavelength Array (LWA)
- Low-Frequency Array (LOFAR)
- Mauna Loa Solar Observatory (MLSO)
- Meudon Observatory
- MIT Haystack's Millstone Hill Geospace Facility
- Nançay Decameter Array (NDA)
- Nobeyama Radioheliograph (NoRH)
- Osservatorio Astronomico di Roma
- Pic du Midi Observatory
- Sardinia Radio Telescope (SRT)
- Sayan Solar Observatory
- Siberian Radioheliograph (SRH)
- SST

And in Space: Hinode, IRIS, SDO, SOHO, STEREO, SORCE, NuStar, GOLD, ACE, Wind, PSP, AIM, Geotail, ICON, MMS, TIMED, Themis, Van ALLEN, Juno, Maven, New Horizon, and many more

PARKER SOLAR PROBE

A MISSION TO TOUCH THE SUN



Parker Solar Probe

Encounters Supporting Campaigns

Nour E. Raouafi – Project Scientist

Johns Hopkins Applied Physics Laboratory, Laurel, MD

Nour.Raouafi@jhuapl.edu

WHPI Workshop, Sep. 15, 2020

PSP Encounter 4 & 7
Science Opportunities

- **Sun–(inner) heliosphere:** PSP shows a strongly coupled system more than we thought
- **PSP-Sun connection:** need as many eyes as possible to help build the big picture
- **Encounter 7:**
  - Can be seen from Earth
  - Provides opportunities for synergies with ground-based observatories and space missions

Campaigns carried out with success including tens of worldwide ground-based observatories and space-born missions

Supporting Campaign for Encounters 4 & 7

~50 observatories around the globe support Parker Enc. 4

- Ground: >40 observatories
- Space: Hinode, IRIS, SDO, STEREO, NuSTAR, MMS, …
- Modeling: 5 teams provide predictions of the SC B-connectivity
- Coordination:

Table 1: Observations types, Leads and their roles, and the level of support for PSP Encounter 4.

	Role	Main Contact(s)	Level of Support
Project Science	PSP Project coordination	Robert Allen (JHUAPL)	Overall coordination
Ground-based observations (optical)	Provide magnetic field maps and images at different wavelengths and heights in the solar atmosphere	Sarah Gibson & Giuliana de Toma (NCAR/HAO)	22 observatories
Ground-based observations (radio)	Provide radio data such as radio bursts, etc.	Angelous Vourlidas (JHUAPL)	13 observatories
Ground-based Geospace observations	Provide ionospheric and mesospheric observations on the geospace response to solar inputs		6 observatories
Space observations	Provide X-rays, EUV and magnetic field data at the base of the corona	Harry Warren (NRL)	9 missions
Modeling	Provide predictions of the S/C magnetic connectivity to the solar surface	Pete Riley (PSI) Nick Arge (GSFC)	6 models
Data management	Data management through the WHPI infrastructure	Barbara Thompson (GSFC)	Data distribution

PSP E7: Ground-Based Optical Solar Observatories

Observatory	Location/Time	Observations	POC
Mauna Loa Solar Observatory (MLSO)	Big Island of Hawaii, USA 19.5°N 155.6°W Daily (1700-0200UT)	• White light polarization brightness (pB) • Coronal electron densities • 15s cadence	Joan Burkepile
Big Bear Solar Observatory (BBSO)	California, USA Daily	• Imaging spectroscopy and polarimetry • 0.1” resolution	Wedna Cao Haimin Wang
Dunn Solar Telescope	New Mexico, USA Jan 15-31 (1500-1700UT)	• Imaging and spectroscopy at multiple wavelengths • IR spectro-polarimetry	Damian Christian
Sayan Solar Obbservatory	Russia 51.6°N 108°E Daily	• Spectrograms and vector magnetograms • Coronal obbservations	Misha Demidov
Baikal Astrophysical Observatory	Russia 54.8°N 105°E Daily	• CaII K • Magnetic Field	Misha Demidov
Kislovodsk Observatory	Russia 43.7°N 42.3°E	• Full-disk CaII K and Halpha (1m cadence) • Photospheric magnetograms	Andrey Tlatov

PSP E7: Ground-Based Optical Solar Observatories

Observatory	Location/Time	Observations	POC
Fuxian Solar Observatory 1m NVST telescope	China 24.6°N 103°E 0100-0800UT	• High-res 0.3” Halpha images with 11s cadence • High-res ~0.1” (after reconstruction) images in the TiO band with 30s cadence	Zhi Xu
Huairou Solar Observing Station (HSOS)	China 40.4°N 116.6°E 0030-0830UT	• Halpha • Photospheric vector magnetic fields • Chromospheric LOS magnetic fields	Xianyong Bai
ONSET Telescope	China		Pengfei Chen
Istituto Ricerche Solari Locarno (IRSOL)	Locarno, Switzerland 46.2°N 8.8°E	• High-precision polarimetry in the Cal 422.7 nm limb (both limb and disk) • Other possible lines include: Na I D1 and D2, He D3, H-alpha, and a C2 molecular band	Renzo Ramelli Michele Bianda
Kanzelhöhe Observatory	Austria 46.7°N 13.9°E Daily	• Full-disk images in Halpha, CaII K, and white light • 10 images/minute (4 images/s in flare mode)	Werner Pötzi
Hvar Observatory	Zagreb, Croatia 43.2°N 16.5°E 0600-1300UT	• Halpha and white light high cadence 2s images • FOV 7 and 11 arcmin, 1” spatial resolution	Jasa Calogovic

PSP E7: Ground-Based Optical Solar Observatories

Observatory	Location/Time	Observations	POC
Astronomical Observatory of Rome (PSPT)	Monte Porzio Catone, Rome, Italy	• Full-disk CaII K, G-band, res and blue cont. • ~2" resolution, 0.1% pixel-to-pixel precision	Ilaria Ermolli
Catania Solar Observatory	Catania, Sicily, Italy 37.5°N 15.1°E	• Full-disk images in Halpha and cont at 656nm • 2" spatial resolution • 1m cadence in campaign mode	Paolo Romano
Pic du Midi	Pyrenees, FR 42.9°N 0.1°E	• Coronagraphic observations in Halpha and HeI, possibly in Fe XII 1074 nm	Frederic Pitout Arturo Lopez Ariste
Meudon Observatory	France 48.8°N 2.3°E Daily	• Full disk Halpha	Jean-Marie Malherbe
NSO/GONG Netword	Multiple locations ~90% duty cycle	• High-sensitivity magnetograms, velocity and intensity images at 1m cadence • Near-real-time seismic images of the farside • Halpha images at 20s cadence	Alexei Pevtsov
Mitaka Observatory	Japan	• Full-disk Halpha, G-band, CaII K, cont. • Halpha velocity maps • Full-disk magnetograms in He 10830Å, Si 10827Å, and Fe 15648Å	Yoichiro Hanaoka

PSP E7: Ground-Based Optical Solar Observatories

Observatory	Location/Time	Observations	POC
Hida Observatory	Japan	• Full-disk Halpha images	Kiyoshi Ichimoto
Félix Aguilar Observatory	Argentina 31.8°S 69.3°W	• Full-disk H-alpha center line with a 1m cadence • 30 THz camera (70% of the disk) with 1s cadence	Carlos Francile
Latin America Giant Observaory (LAGO)/NEWRUS	Marambio, Antartica 64°S 57°W (etc)	• Cosmic rays 2-100 GeV	Sergio Dasso
Crimean Astrophysical Observatory (CrAO)	Crimea	• Monochromatic and spectral images	Valentina Abramenko

PSP E7: Ground-Based Radio Solar Observatories

Observatory	Location/Time	Observations	POC
Arecibo			Mike Sulzer Msulzer@naic.edu
Expanded Owens Walley Solar Array (EOVSA)	California, USA Daily (1600-2400UT)	• Microwave spectra and imaging 1-18GHz • Full-disk images 1/day at 6 frequency bands • Full-Sun-integrated spectrograms, 1s cadence	Dale Gary Sherry Chhabbra Bin Chen
Very Large Array (VLA)	New Mexico, USA Jan 28, 30, 31 (TBC)	• Imaging at 1-2 GHz & 230-470 MHz	Tim Bastian
	Jan 27	• Full-disk mosaic L & S band	Stephen White
Long Wavelength Array (LWA)	New Mexico, USA Jan 27-30 (TBC)	• 20-80 MHz spectroscopy	Stephen White
Nobeyama Radioheliograph	Japan 2300-0600 UT	• Full-disk images at 17 and 34 GHz	Satoshi Masuda
Kislovodsk Observatory	Russia 43.7°N 42.3°E	• Radio observations at 3 and 5cm	Andrey Tlatov
MeerKAT	South Africa		Du Toit James Chibueze

PSP E7: Ground-Based Radio Solar Observatories

Observatory	Location/Time	Observations	POC
Siberian Radioheliograph	Siberia, Russia 51.8°N 103°E Daily 0200-0800UT	• Full-disk images at 16 or 32 bands in 4-8 GHz range	Maria Globa Alexander Altyntsev Sergey Lesovoi
Huairou Solar Radio Spectrograph	China		Baolin Tan
Low-Frequency Array (LOFAR)	Netherlands	• Solar imaging range 20-70MHz • High-res solar dynamic spectra 10-77MHz and 110-190MHz	Richard Fallows Pietro Zucca
Murchison Widefield Array	Austrailia	• Imaging spectroscopy at 24 bands 80-240 MHz • 0.5s and 40 kHz resolution	Divya Oberoi
Sardinia Radio Telescope (SRT)	San Basilio, Sardinia, Italy 39.5°N 9.2°E Jan 28 0800-1500UT	• Full-disk solar images at 18 and 26 GHz • ~50" arcsec angular res	Alberto Pellizzoni
Nançay Decameter Array	France 47.4°N 2.2°E Daily	• 10-100 MHz daily spectrograms of the Sun and Jupiter at various cadences (<1s) and spectral resolutions (<175 kHz)	Sophie Masson Laurent Lamy

PSP E7: Ground-based Geospace Observatories

Observatory/Satellite Mission	Observing Window	Observations	POC
PFISR	Continuous (low duty cycle)	• IPY27 (1% duty cycle): 4 beams, long pulse (F-region) and alternating codes (E-region) • Themis36: 23 beams, long pulse (F-region) and alternating codes (E-region) • MSWinds26 (For ELFIN): 4 beams, barker codes (D-region), alternating codes (E-region), and long pulse (F-region) • WorldDay35: 11 beams, long pulse (F-region) and alternating codes (E-region) Calendar: data.amisr.com/database/61/sched/2020/01/	Roger Varney Roger.Varney@sri.com
RISR-N	Continuous (medium duty cycle) Jan 13 - Jan 17 (Themis/MMS) Jan 15 - Feb 15 (10-day SSW World Day on alert)	• LowDuty2 (3.5% duty cycle): 5 beams long pulse (F-region) and 3 beams of alternating code (E-region) • imaginglpReduced (for MMS): 19 beams, long pulse (F-region imaging) • WorldDay68m (for SSW WD): 10 beams, long pulse (F-region) and alternating codes (E-region) Calendar: data.amisr.com/database/91/sched/2020/01/	Roger Varney Roger.Varney@sri.com

PSP E7: Ground-based Geospace Observatories

Observatory/Satellite Mission	Observing Window	Observations	POC
Millstone Hill		• Wide field ionospheric full altitude profiles	Phil Erickson pje@mit.edu
Jicamarca	Jan 15 – Feb 15	• ISR observations for 10 days during the observing window to measure F-region plasma densities, temperatures and drifts.	Marco Milla Marco.Milla@jro.igp.gob.pe
RISR-C	Jan 13 – Jan 17 (Themis/MMS) Jan 15 – Feb 15 (10-day SSW World Day on alert)	• imaginglpReduced (for MMS): 19 beams, long pulse (F-region imaging) • WorldDay68m (for SSW WD): 10 beams, long pulse (F-region) and alternating codes (E-region) Calendar: data.amisr.com/database/91/sched/2020/01/	Rob Gillies Rgillies@ucalgary.ca
Ground Based Magnetometers (USGS, SuperMag, etc)		• Ground-based magnetic field measurements	

PSP E7: Space-bases Missions

Observatory/Satellite Mission	Observing Window	Observations	POC
SDO		• EUV full-disk images, AIA images	Dean Pesnell Barbara Thompson
Hinode		• X-ray images, Magnetograms, and Ca II images	Harry Warren
IRIS		• Multi-wavelength spectroscopy and imaging	Bart De Pontieu
STEREO		• Full disk EUV images and plasma measurements	Angelos Vourlidas
NuSTAR		• X-ray images	Lindsay Glesener Jessie Duncan
ARTEMIS		• Field and plasma measurmenets	Vassilis Angelopoulos
COSMIC		• Ionospheric reaction to solar input	Charles Lin Charles@mail.ncku.edu.tw
MMS	Jan 25th – Feb 8th	• Extended science region of interest in solar wind to collect fast survey mode data • 4 sec thermal ion/e- (FPI), 16 vec/s B (FGM), 64 vec/s E (EDP), 10 sec thermal ion composition (HPCA)	Rick Wilder Frederick.Wilder@lasp.Colorado.edu Tai Phan phan@ssl.Berkeley.edu

PSP E7: Space-bases Missions

Observatory/Satellite Mission	Observing Window	Observations	POC
TIMED			Martin Mlynczak M.G.Mlynczak@nasa.gov
ICON	Continuous, excluding brief calibration activities	• Thermospheric winds, lower thermosphere temperatures, O+ density day and night, O/N2 ratio daytime, O+ drift in situ.	Thomas Immel Immel@ssl.berkeley.edu

PSP Encounter 11
Science Opportunities

- **Encounter 11:**
  - Can be seen from Earth
  - Provides opportunities for synergies with ground-based observatories and space missions
  - PSP will spend significant time in the sub-Alfvenic solar wind
  - Solar activity is picking up

We are soliciting support for encounter 11 from as many ground-based observatories and space-born missions as possible

Parker Solar Probe Scholars

An Open Forum to Promote Early-Career Scientists & Diversity in Heliophysics

- Open to all helio-scientists worldwide
- 350+ scientists joined the PSP Scholars

- Third Meeting: Nov. 9-10, 2021
- ● Presenters at the PSP-Scholars second meeting
- Symbols show affiliations of PSP Scholars members

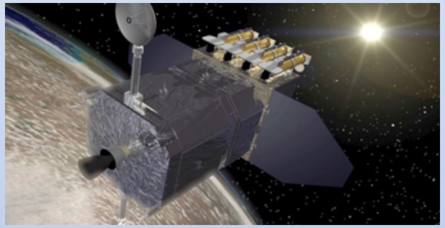
Parker Two Conference

June 21-24, 2022

DC area – Venue will be announced soon

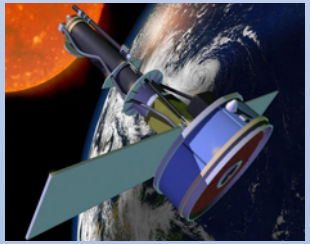

NASA
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY
PARKER SOLAR PROBE
A MISSION TO TOUCH THE SUN

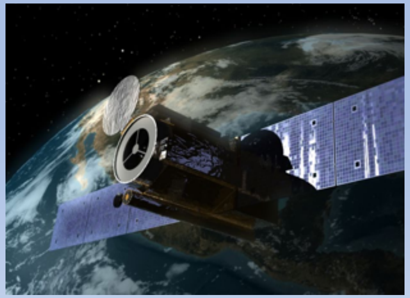
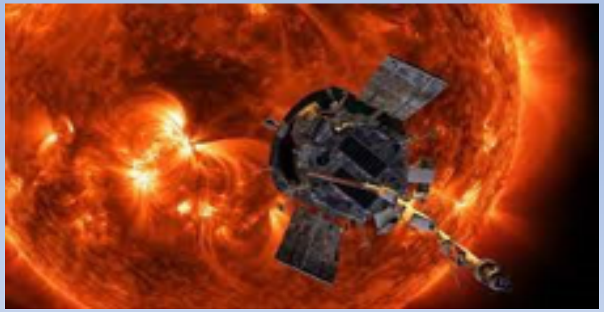
PSPs 8th perihelion:
Cororonal holes, open magnetic funnels, and the origin of the solar wind





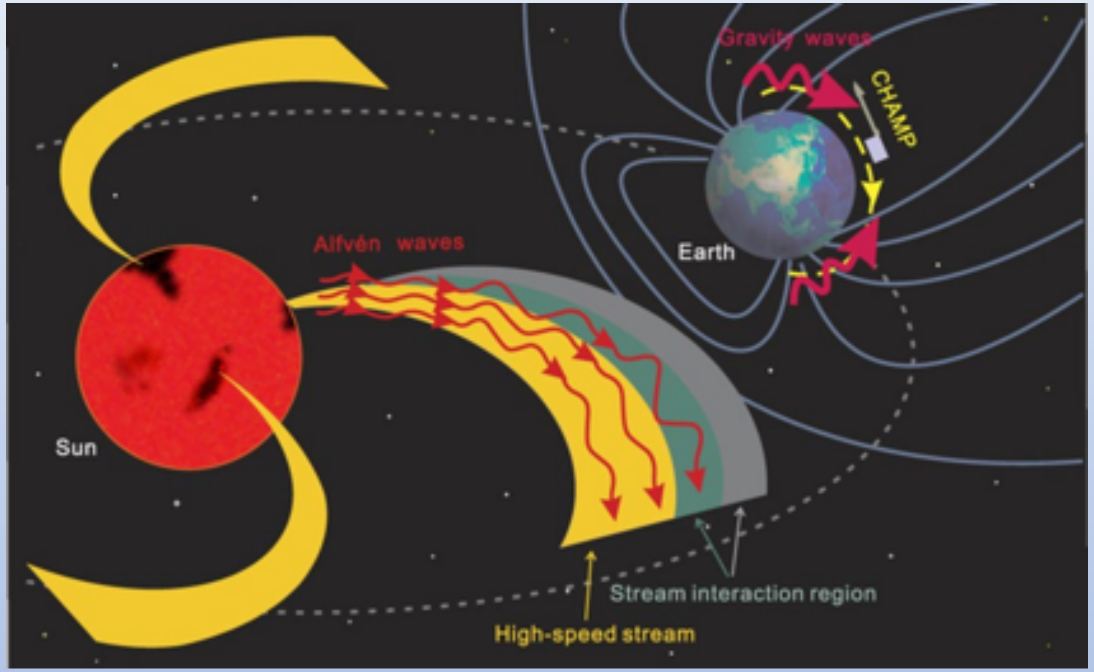





Effects of high-speed solar wind streams

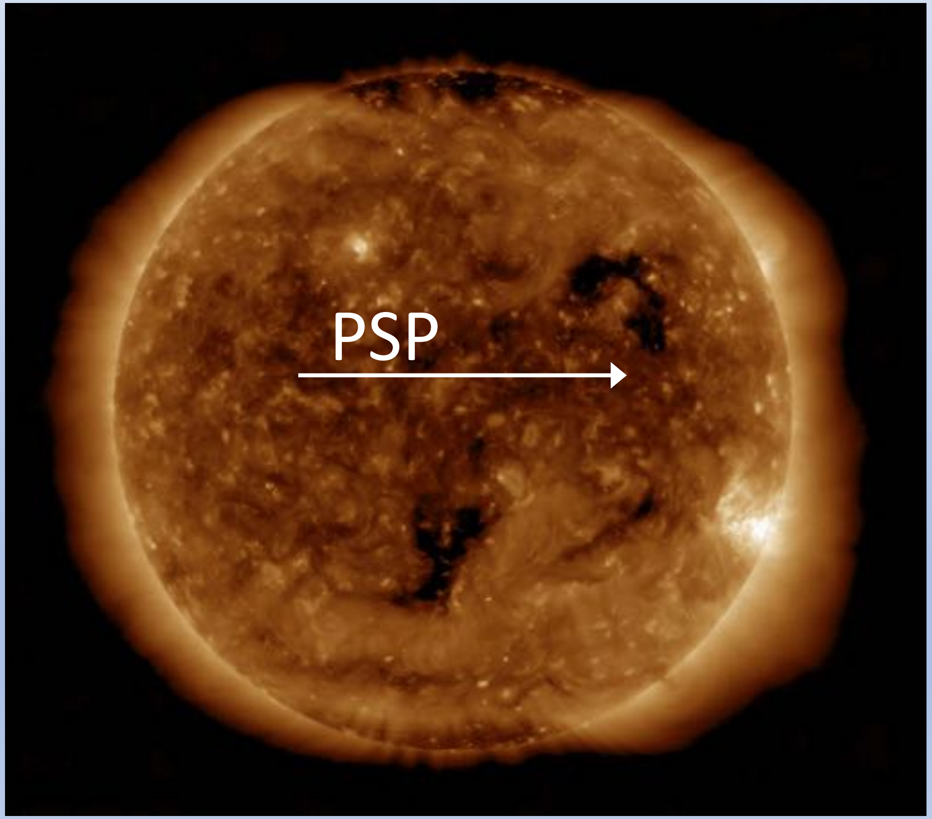
- HSS rarefaction: preconditions interplanetary space for subsequent CMEs
- Stream Interaction region: Energetic particle acceleration
- Interaction with Earth's magnetosphere: geomagnetic storms and substorms



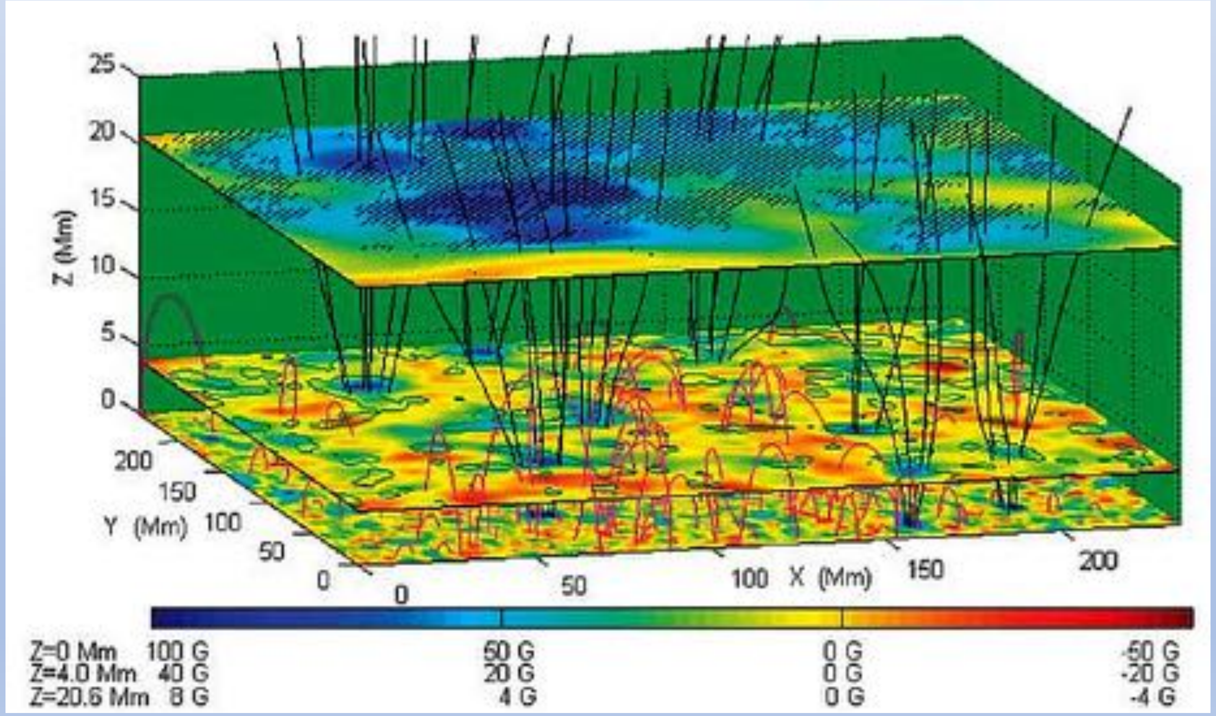
We need to understand the origin and properties of HSSs close to the Sun to be able to predict their propagation

Coronal holes are built up from open magnetic funnels.

<u>Main focus:</u> Where are the open magnetic funnels rooted,
how do they determine the properties of coronal holes,
and how do their properties affect the solar wind acceleration?

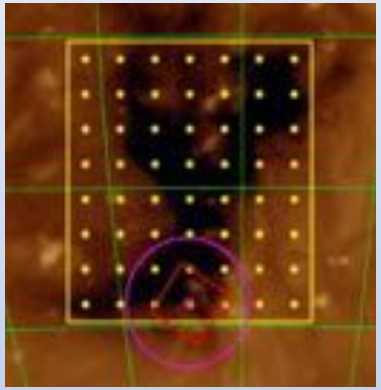


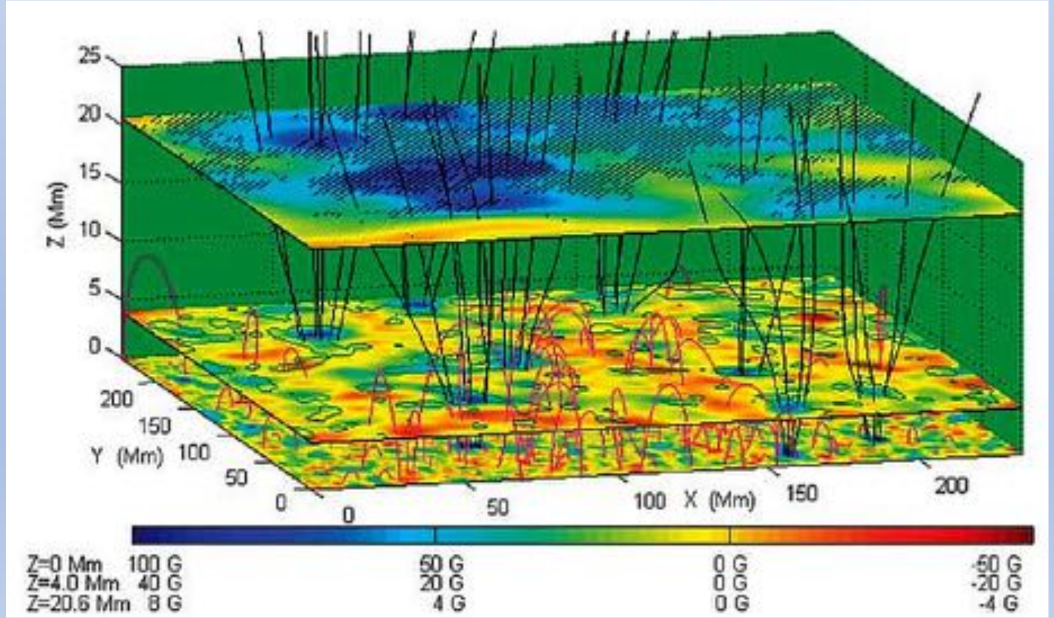
SDO/AIA 193 Å, 04/30/2021



Instruments involved

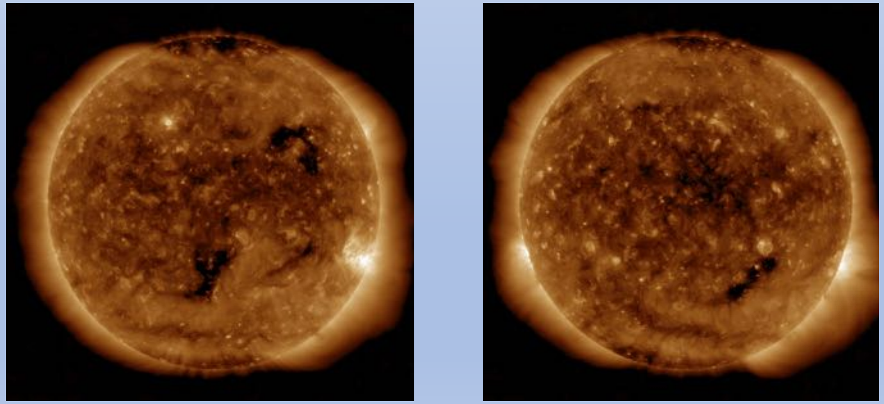
- Visible regime
  - Photosphere and chromosphere
  - GREGOR, DST, SST, GST
- EUV regime
  - Chromosphere, low corona
  - IRIS, Hinode, SDO
- Radio regime
  - from the chromosphere to the high corona
  - LOFAR, EOVSA, Sibirian Radioheliograph
- PSP
  - Solar wind at 15-70 solar radii
- Earth was aligned with the coronal hole
- > 40 scientists involved!





What else happened during PSPs 8th perihelion?

- Features seen by PSP
- Magnetic reconfiguration of the corona
- Several small Type III radio bursts
- C8 Flare + Type III radio burst on May 8th



SDO/AIA 193 Å, 04/30/2021 + 05/02/2021

Everybody who wants to join is welcome!