Science JOPs: JOP 006

Title: SOLAR WIND FROM ACTIVE REGIONS

Lead Person: Ester Antonucci

Authors: E. Antonucci and J. Kohl (UVCS), P. Lemaire (SUMER), R. Harrison (CDS), T. Hoeksema (MDI), R. Howard (Lasco)

SOHO Instruments involved: UVCS, SUMER, CDS, LASCO, EIT, MDI

Collaborating GBO: Possible collaborations: white light coronagraphs (polarization), radio observatories

Collaborating S/C: Yohkoh

Campaign: yes

First proposed: SPWG June 1994

Object: Active Regions

SOLAR WIND FROM ACTIVE REGIONS (JOP 006)

Objective
To identify and characterize the coronal sources of the solar wind: Active Regions role

Scientific Case
The primary scientific goals of the observing program are the following:

- to identify and characterize the coronal sources of the solar wind,
- to identify and understand the dominant physical processes that accelerate the solar wind.

The first goal of the investigation is to identify definitively the sources of non-transient high speed wind and of low speed wind, and to characterize the physical conditions of the different sources of solar wind at the base of the corona, as well as their evolution throughout the corona up to a few solar radii. The recent Ulysses data on solar wind are clearly showing a strong variation of the wind properties as a function of latitude, as expected, and a peculiar wind speed behavior above the streamer belt. Active regions have been recently proposed as possible sources of wind by Uchida et al. (1992) on the basis of the observations of the Soft X-ray Telescope on Yohkoh which suggest a continuous expansion of the coronal loops with a non negligible mass and magnetic field contribution to the wind. It is therefore crucial to obtain a detailed description of the physical conditions of the wind and its boundary conditions at the solar surface in correspondence to high-latitude sources such as coronal holes, to streamers at middle latitude and their interface region with the surrounding atmosphere, to the quiet sun and to active regions. In this specific observing program we limit our investigation to active regions as possible sources of solar wind.

The second goal consists in using the physical parameters of the solar wind region and its boundary at the solar surface to identify the dominant acceleration mechanisms, for example to determine the roles of thermal pressure gradients (Parker type wind), wave-particle interactions, and non-thermal electrons in accelerating the solar wind in the different regions. We also aim to distinguish between the effects of waves that damp in the lower corona (acoustic waves, fast mode MHD waves) and waves that survive to heat and accelerate the solar wind beyond the critical point.

This program is limited to:

- determine the mass input and energy and momentum deposition in the solar wind for:
  Active Regions
- test the hypothesis/observation of Uchida of mass input from Active Regions.

Observables

- extended corona (UVCS, LASCO)
  ————————-
  determine kinetic temperature for protons and heavier ions, electron density, outflow velocity of the corona from the limb up to 2.5 $R_\odot$, in the solar wind region.
- inner corona (CDS, EIT, SUMER, MDI)
  —————————
  determine:
  - electron density and temperature
  - differential emission measure on disk near the limb and possibly up to 1.5 $R_\odot$
  - non-thermal velocity maps in
    - transition region
    - coronal lines
  - fine (2") photospheric magnetic structures in the potential solar wind sources (at least at the beginning of the tracing of the target).

Pointing and Target Selection

It is desirable to begin to observe the target region (active region) a few days before arrival at the limb, in the inner corona, to fully characterize the potential solar wind sources. The coronagraphs shall start the joint observation when the target is approaching the west limb, continuing for the period of visibility at the west limb.

Observations

UVCS

The UVCS observations consists of a mirror scan.

MIRROR SCAN

Channel I: Ly α, Fe XII 1242, N V 1239, S X 1196 (S X 1213) profiles
Channel II: O VI 1032, O VI 1037, Mg X 610, Ly β 1026, Si XII 499, Si XII 521, Ly α profiles
Channel III: VL polarized 4500–6000 Å.
To determine electron density, proton/ion kinetic temperature, outflow velocity.

	Ch I – H Ly α	Ch II – O VI
Initial IFOV position	1.5 $R_\odot$ at the target latitude	$\|\|$ to the limb
Instantaneous FOV (IFOV)	30' x 14"	30' x 28"
Slit width	0.05 mm	0.1 mm
Spectral resolution	0.28 Å	0.36 Å
Area element (n. pxls)	28" x 14" (2 x 2)	28" x 28" (8 x 8)
F.O.V.	1.5– 2.5 $R_\odot$	
Average dwell time	variable with height	
Total time	10. h	

Observing Sequence JOP-06

Exposure time	600 sec	
Dwell time	variable with height	
Total bins	40000	
Polarizer motion	each	600 sec
	Channel 1 (Ly alpha)	Channel 2 (OVI)
Slit Width	0.05 mm (0.28 Å, 14")	0.1 mm (0.36 Å, 28")
Grating Position	95000	185000
Mask:	GPS2-LYA	GPS2-OVI
Binning along the slit	4 pxls=28"	4 pxls=28"
Binning in λ	2 pxls=0.28 Å	2 pxls=0.18 Å
Full spatial range	90 bins	90 bins
Selected spatial range	64	64 (72-328)
Spectral bins	625	available for transmission
Spectral Range	column interval	column interval
	500–879 (190 b)	280–469 Si XII 521–OVI 1037 (95b)
	–Fe XII 1242–NV 1239–	OVI 1032–Ly β 1026
	Lyα 1216–SX 1213,1196	Si XII 499 Mg X 610, Lyα+wings
		700-1019 (160b)
Total spectral bins	190 bins	255 bins
Bins per channel	190x64= 12160	255x64 = 16320
Total bins	28480	
Field of View	30'x 14"	30' x 28"
Scan step	variable	
Scan time	(for photon integration)	34200 s (9.5 h)
Scan time	(including polarizer motion)	35340 s (**9.8 h**)
Number of scans	1	
Total time	**10 h**	

Corona above Active Region
N–Predicted Counts)

$R_\odot$	Δt	Ch1	$N_{Ly\,\alpha}$	Ch2	$N_{OVI1032}$	
	(sec)	pxl^2		pxl^2		
1.50	1800	4x 2	1.8e+04	4x 4	4.8e+03	1.9e+03
1.60	1800	4x 2	1.9e+04	4x 4	4.5e+03	1.8e+03
1.70	1800	4x 2	1.7e+04	4x 4	3.6e+03	1.4e+03
1.80	3600	4x 2	3.1e+04	4x 4	5.8e+03	2.3e+03
1.90	3600	4x 2	2.7e+04	4x 4	4.8e+03	1.8e+03
2.10	5400	4x 2	3.2e+04	4x 4	4.9e+03	1.8e+03
2.30	7200	4x 2	3.4e+04	4x 4	4.5e+03	1.7e+03
2.50	9000	4x 2	3.2e+04	4x 4	3.8e+03	1.4e+03

CDS

- CDS can observe an active region near the limb with the largest FOV

  Line selection:

  1. Density sensitive ratios:
     Mg VII 319.03/367.67 Å, Si IX 349.87/341.95 Å, Si X 347.40/356.04 Å, Fe XII 338.27/364.47 Å.
  2. Bright lines with wide temperature range:
     O III 599.59 (9 10^4 K), O IV 554.52 Å(2 10^5 K), Ne VI 562.83 Å(4 10^5 K), Mg VIII 317.01 Å(9 10^5 K), Fe XIII 359.64 Å(1.6 10^6 K), Fe XIV 334.17 Å(2 10^6 K)

  Operation

Spectrometer	NIS
Pointing	to AR near limb
Slit	4 x 240 arcsec
Raster area	240 x 240 arcsec
Raster locations	60
Exposure time at each	15 sec
Total duration	900 sec
Lines selection/extraction	14 lines listed above
	Sum 11 pxls across each line
Repeat many times over specified period	

SUMER

- – A. Observations on the solar disc.
    1. Making rasters simultaneously in several wavelengths with full profile:

       * O VI 1027, O VI 1032, HI Lyβ 1025

Slit size:	1" x 300"
step size:	2 x 0.76"
raster size:	300" x 240"
dwell constant:	10 sec
binning:	2 x 2
time to perform a raster:	1500 sec

* N V 1238, N V 1242, Fe XII 1242, O V 1218, Mg X 609, Mg X 625, C I 1253

Slit size:	1" x 300"
step size:	2 x 0.76"
raster size:	300" x 240"
dwell constant:	20 sec
binning :	2 x 2
time to perform a raster:	3000 sec

2. Repeat as long as needed.

– B. Observations above the limb (POP type 04) Scan off-limb, starting at 0.1 $R_\odot$ inside and going outward up-to-1.5 $R_\odot$.

Slit size:	beginning with 1" x 300" up to 0.01 $R_\odot$ then 4" x 300"
step size:	12 full step up-to-0.01 $R_\odot$ 24 full step (0.01 $R_\odot$ - 0.2 $R_\odot$) 36 full step (0.2 $R_\odot$ - 0.5 $R_\odot$)
dwell time:	25 sec increasing to 1200 sec
duration of scan:	5 h
wavelengths:	
first scan:	O VI 1027, O VI 1032, HI Lyb 1025
second scan:	N V 1238, N V 1242, Fe XII 1242, O V 1218, Mg X 609, Mg X 625

MDI

MDI will contribute its standard set of full disk 4" resolution photospheric magnetograms taken every 90 minutes and additional high resolution magnetograms when the region of interest is in the high resolution field of view. Potential field extrapolated coronal field lines can also be provided. Continuum intensity images are also available.

Full Disk Magnetograms

FD magnetic field observations are taken every 90 minutes. The FD images have 4" resolution and accuracy of about 20 G. They are observed in the Ni I 6768 line in the mid photosphere.

High Resolution Magnetograms

HR magnetograms are avail 3 times per day for areas within the MDI HR field of view. The middle of the HR FOV is 160" north of the center of the the disk, centered EW. The HR FOV is 785" square. The resolution is 1.23". Accuracy is about 20 G. Extra HR Magnetograms can be scheduled if the region of interest is in the HR FOV..

Continuum Images

FD and HR continuum (near Ni I 6768) are available 3 times per day. Additional images can be obtained if desired.

If real time data are required for additional images, extra VC2 data will be required.

Modeled Coronal Magnetic Field

A potential field model extrapolation of the coronal field based on the photospheric observations can be provided to approximate the locations of closed and open field regions.

LASCO

The LASCO primary observables for coronal hole structures will be to determine electron densities, kinetic temperatures, velocities associated with the hole, structures within the hole and structures at the boundaries of the hole. The observations are from the C1 telescope. The C2 observations to obtain electron densities will be taken as part of the normal LASCO synoptic program.

Telescope: C1 Passbands: Fe X and Fe XIV FOV: 512 x 256 pixels (48 x 24 arc min) Wavelengths: 6 + 1 off band Resolution: Full spatial resolution Compression: Rice (lossless) TM Downlink: 21 minutes Cycle Repeat: Once at beginning, middle and end of period

A cycle will require several repeated exposures at each wavelength step with on-board summing to be able to obtain a total exposure time at each wavelength step of about 5 minutes.

EIT

Synoptic observations.