June 27 – July 1, 2022; Honolulu, HI, USA

Solar Cycle Variations of the Solar Wind Dynamic Pressure and Consequences for the Heliosphere as seen by Energetic Neutral Atoms

Justyna M. Sokół (justyna.sokol@swri.org), Maher A. Dayeh; Southwest Research Institute, San Antonio, TX

SOUTHWEST RESEARCH INSTITUTE

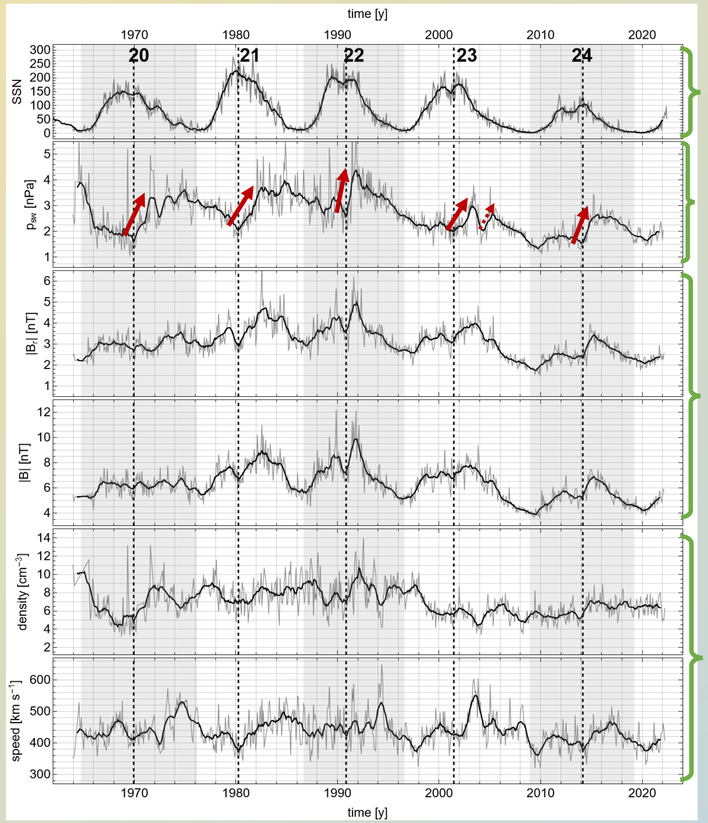
What process drives the increase in dynamic pressure?

- Solar wind dynamic pressure, a combination of solar wind speed and density ($p_{sw} = n_p v_p^2 (m_p + n_\alpha/n_p m_\alpha)$), varies with the solar cycle as measured in the ecliptic plane (data source: OMNI).
- The in-ecliptic solar wind speed and density do not show a solar cycle variation typical for the variation of the sunspot number, solar EUV radiation, or the magnetic field.
- Despite this, the solar wind dynamic pressure increases rapidly* every solar maximum.

*** Parameters of the dynamic pressure increase**

SC	$t_{start,p} - t_{start,SC}$ [years]	Duration [years]	p_{end}/p_{start}
20	5.2	1.72	2.08
21	4.1	2.32	1.83
22	4.2	0.97	1.69
23	4.9	1.79	1.50
23'	*7.8*	*0.89*	*1.32*
24	5.2	1.49	1.71

Solar wind dynamic pressure increases rapidly every solar maximum (period = 10.2 years)

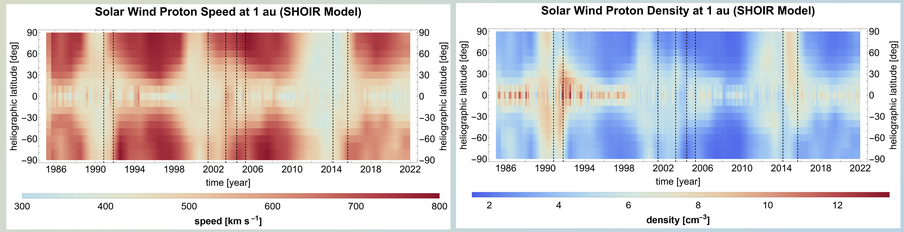


Solar Cycle Variation of Sunspot Number

Solar Cycle Variation of Dynamic Pressure

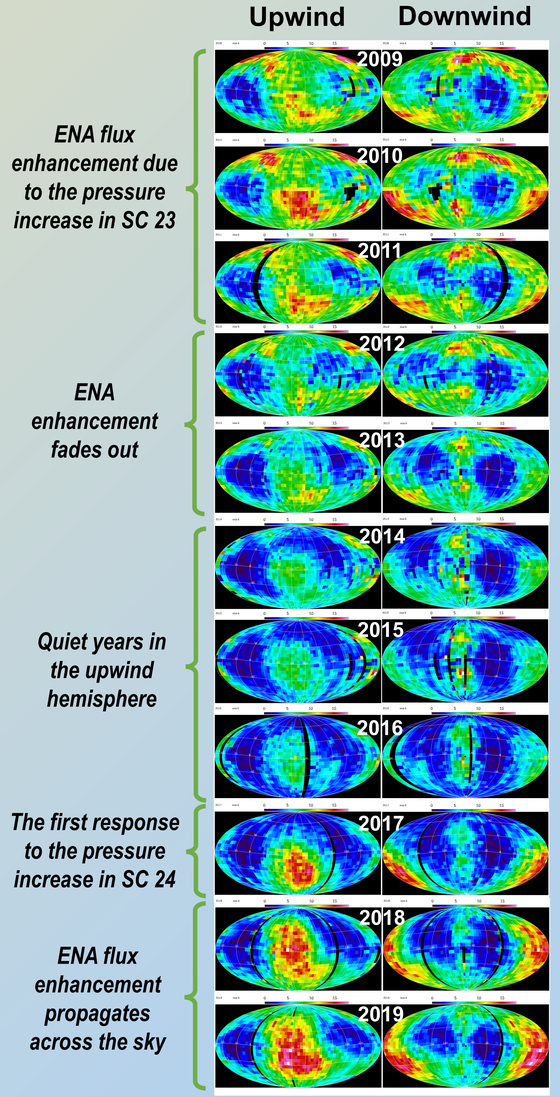
Magnetic Field

Density & Speed



Variation of the latitudinal structure of the solar wind speed and density in time based on the SHOIR model (dashed lines indicate the solar wind pressure increase intervals).

H ENA Full-sky map (4.3 keV, IBEX)



ENA flux enhancement due to the pressure increase in SC 23

ENA enhancement fades out

Quiet years in the upwind hemisphere

The first response to the pressure increase in SC 24

ENA flux enhancement propagates across the sky

- The abrupt change in the solar wind pressure affects the global heliosphere and the processes at its boundaries.
- An increase in the flux of energetic neutral atoms of hydrogen is observed with a few years of delay by the Interstellar Boundary Explorer (IBEX; e.g., McComas et al. 2018, Zirnstein et al. 2018).
- The enhanced flux of H ENAs appears first in the direction of the closest distance of the heliosheath to the Sun (255°, -33°).
- And next propagates across the sky from upwind to downwind in time.

Which portions of the ENA sky map show solar cycle variations?

More in Sokół et al. 2021 (ApJ, 922:250)

About SHOIR model Sokół et al. 2020 (ApJ, 897:179)

This work is supported by the IBEX grant 80NSSC20K0719.