Tracking the Evolution of Polar Coronal Holes using IBEX ENA Observations

PRINCETON UNIVERSITY

Bishwas L. Shrestha, Eric J. Zirnstein, Jamey R. Szalay, David J. McComas

Princeton University, Department of Astrophysical Sciences

Space Physics at Princeton

Introduction

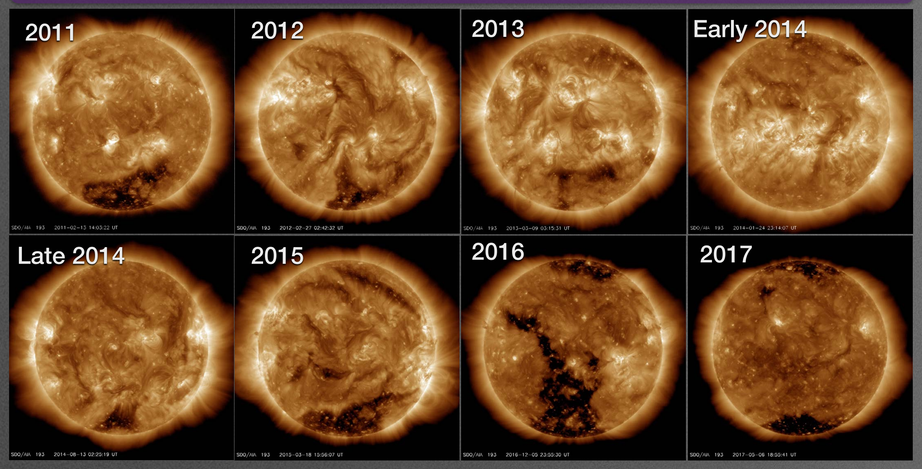

Figure 1: Evolution of Polar Coronal Holes over the Solar Cycle in the South pole (Source: SDO/AIA)

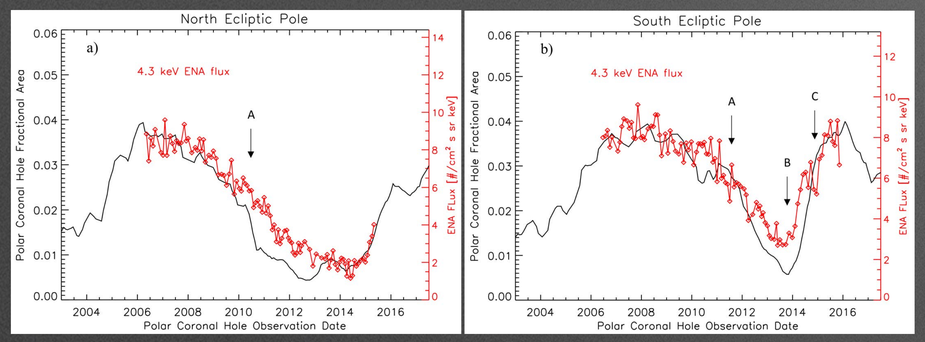

Figure 2: 12-Carrington Rotation running average fractional PCH area (black) in the (a) North, and (b) South ecliptic pole (Reisenfeld et al. 2019)

Evolution of Polar Spectral Index over the Solar Cycle

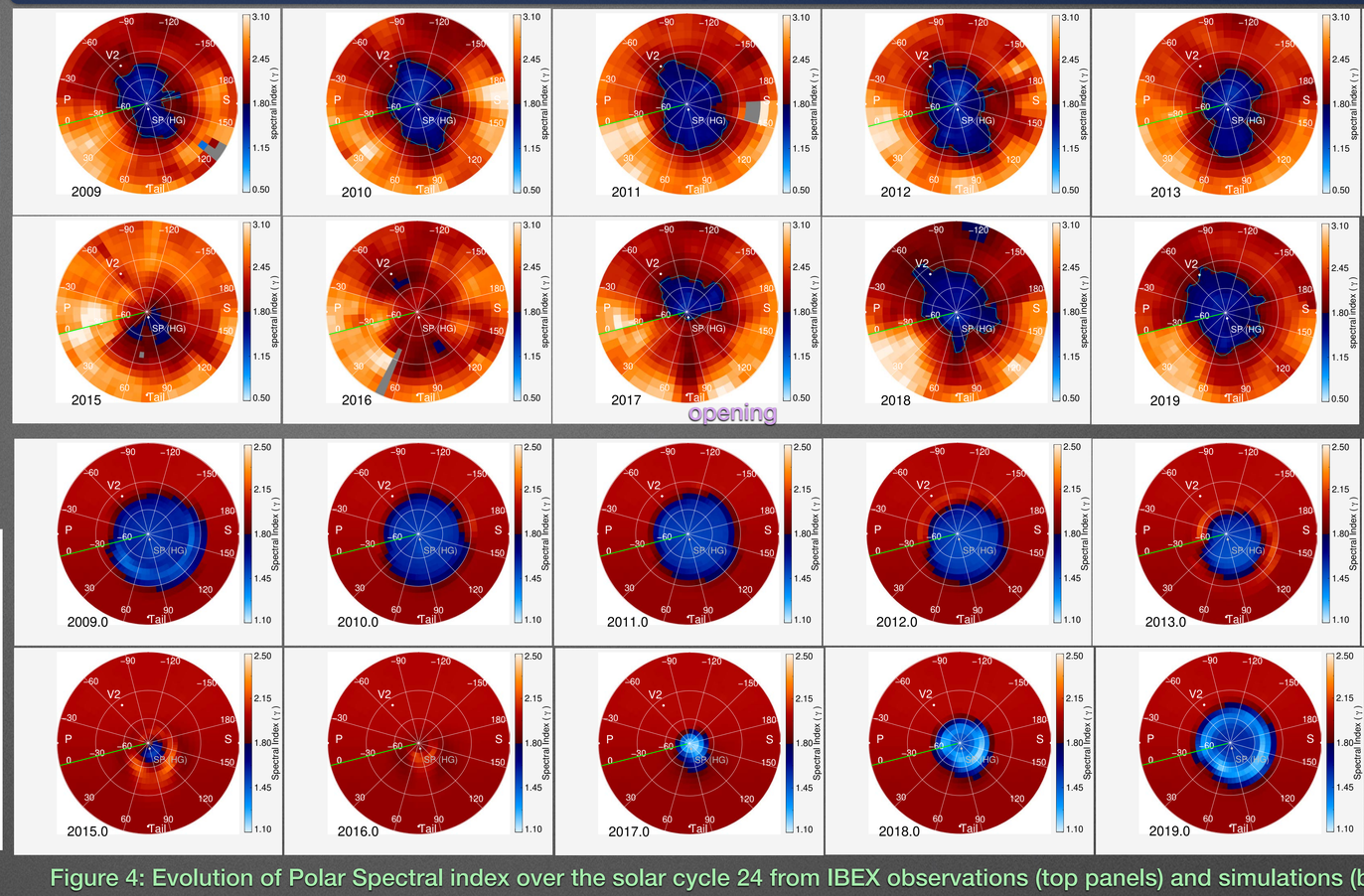

Figure 4: Evolution of Polar Spectral index over the solar cycle 24 from IBEX observations (top panels) and simulations (bottom panels). (Shrestha et al. 2022, in prep)

Time-dependent Potential Flow Model

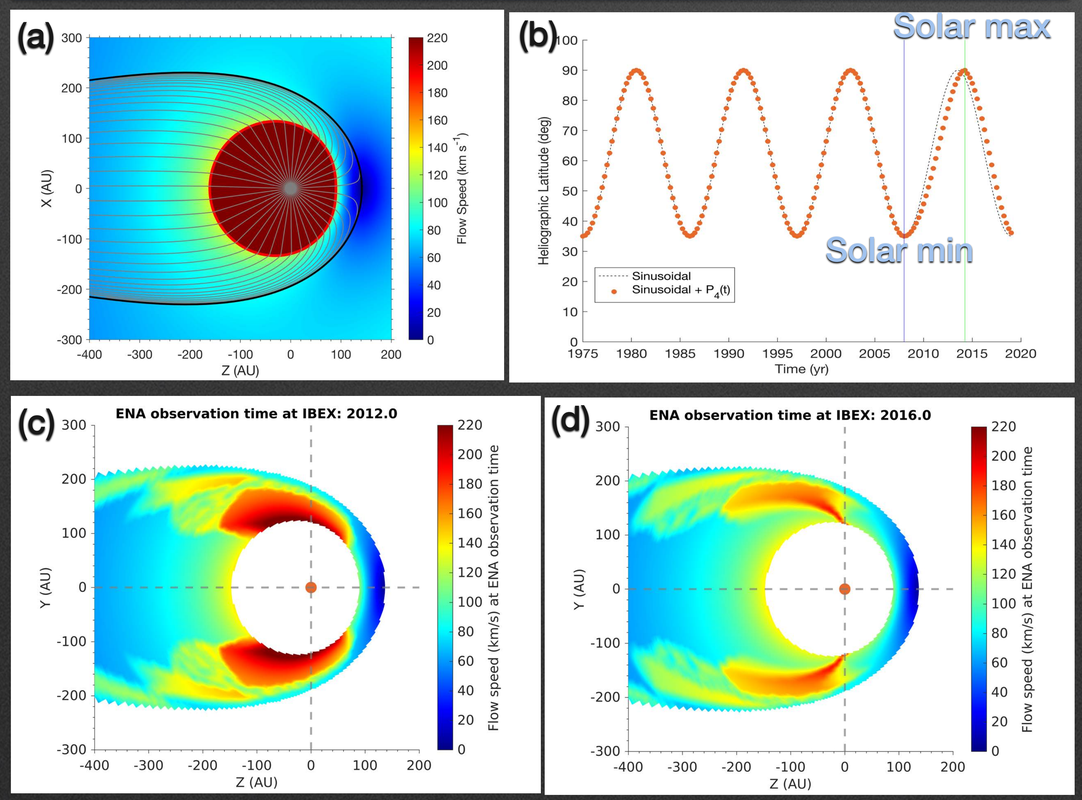

Figure 3: (a) Axisymmetric potential flow model, (b) Latitudinal boundary of fast (~700 km/s) and slow (~400 km/s) solar wind over solar cycle, (c) IHS flow speed near solar-minimum (2012), and (d) solar-maximum (2016) condition.

Latitudinal Variation of ENA Spectral Index

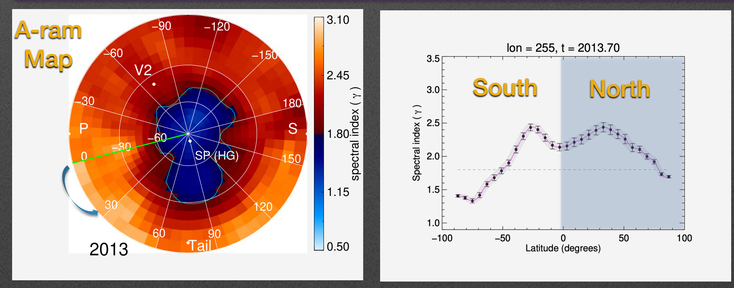

Figure 5: ENA spectral index over the southern hemisphere (left panel), Latitudinal variation of ENA spectral index near the nose direction (right).

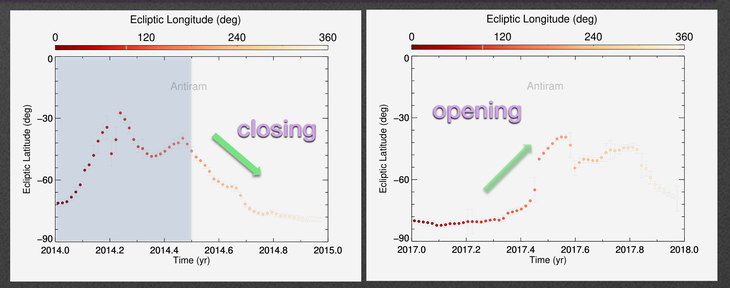

Figure 6: Latitudinal boundary of fast and slow solar wind (γ = 1.8) during closing (left) and opening (right) of polar coronal holes.

Summary and Conclusions

- The ENA spectral slope over the South pole show a periodic evolution over the solar cycle 24: the area with less step ENA spectrum decreased gradually from 2011 to 2014 and then increased again starting 2017.
- This evolution shows a clear correlation with the change in the PCH area observed at the Sun once the delay in the ENA observation time is included.
- The higher-cadence ENA data at the highest latitudes show a rapid evolution of PCHs in the south pole related to their “Closing” in 2014, and “Opening in 2017.
- These results also agree qualitatively with the evolution of ENA spectral slope from simulations using a simple time-dependent heliospheric flow model.

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