On developing a physics-based Heliospheric modeling system: Background Solar Wind

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Current Scenario

Requirement: *to quantify the physical parameters of the corona to get insight into solar wind outflow.*

Problem: *measurement of coronal magnetic field still poses many challenges and at present there's no reliable approach to measure coronal field.*

- SDO/HMI
- GONG

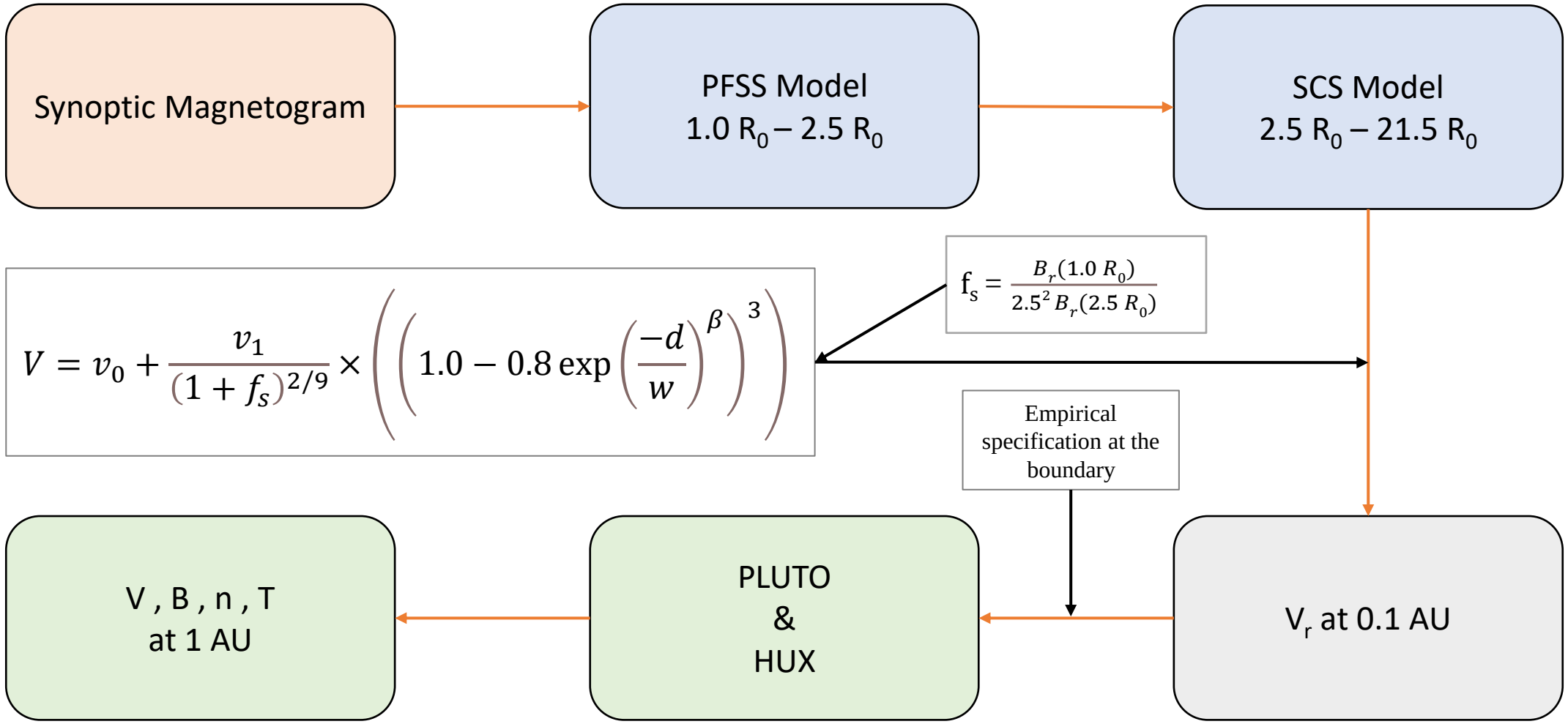
- ENLIL (Odstrcil et al., 94, 96, 03)
- EUHPHORIA (Pomoell & Poedts, 2018)
- SWMF (Sachdeva et al., 2019)
- SUSANOO (Shiota & Kataoka, 2016)

- ADITYA L1
- WIND
- ACE

FROM THE VIEWPOINT OF HELIOSPHERIC WORK

- Data-driven models for the global Solar surface-coronal field
- Data-driven ensemble models of the Solar Wind including magnetic field
- Develop the ability to incorporate the Coronal Mass Ejection in the model and measure its arrival time

Model Flowchart



WSA Model

$$V = v_0 + \frac{v_1}{(1+f_s)^{2/9}} \times \left(\left(1.0 - 0.8 \exp\left(\frac{-d}{w} \right)^{\beta} \right)^3 \right)$$

- McGregor et. al. 2011 :

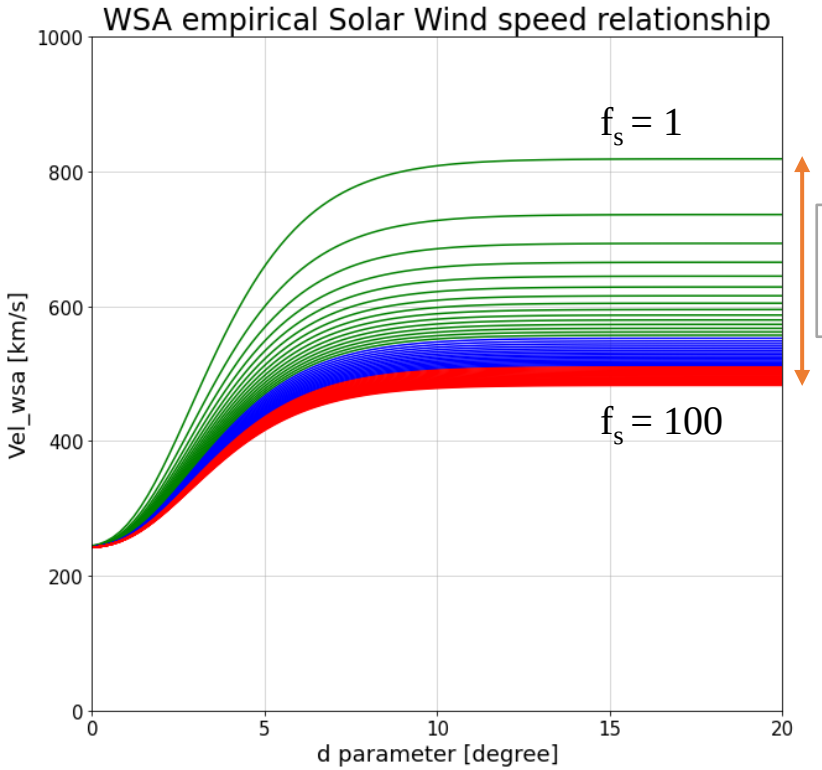
  v_0 = 240 km/s

  v_1 = 675 km/s

  β = 1.25

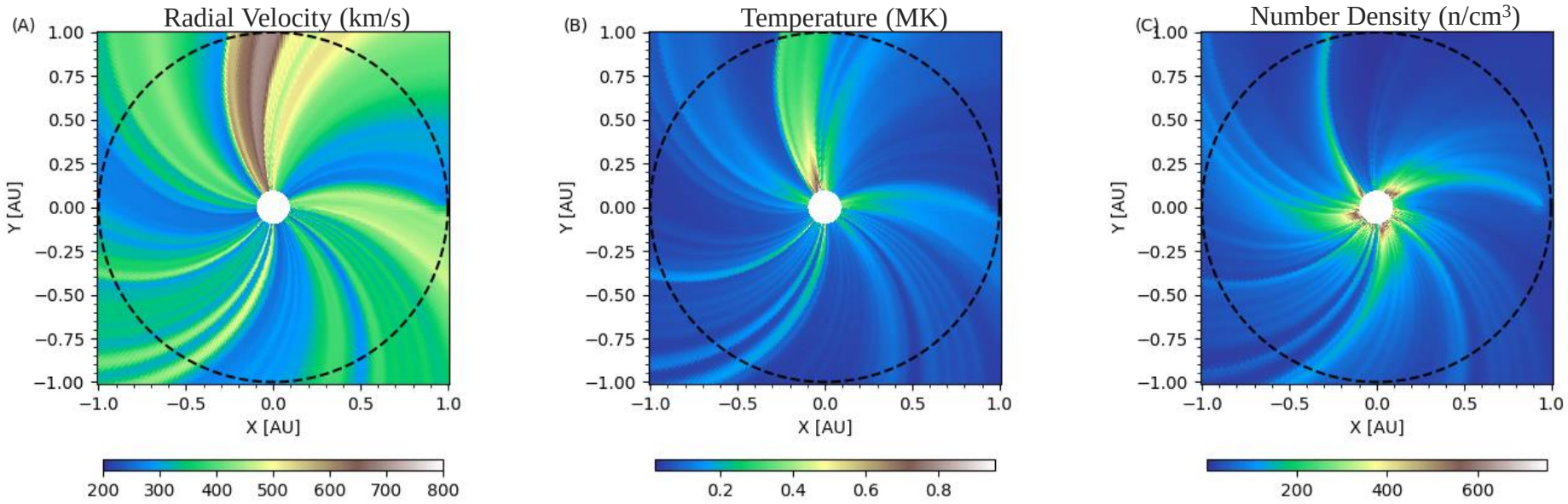
  w = 2.8 degree

- We modified the parameter 'w' and replaced it with the *median of parameter* 'd'

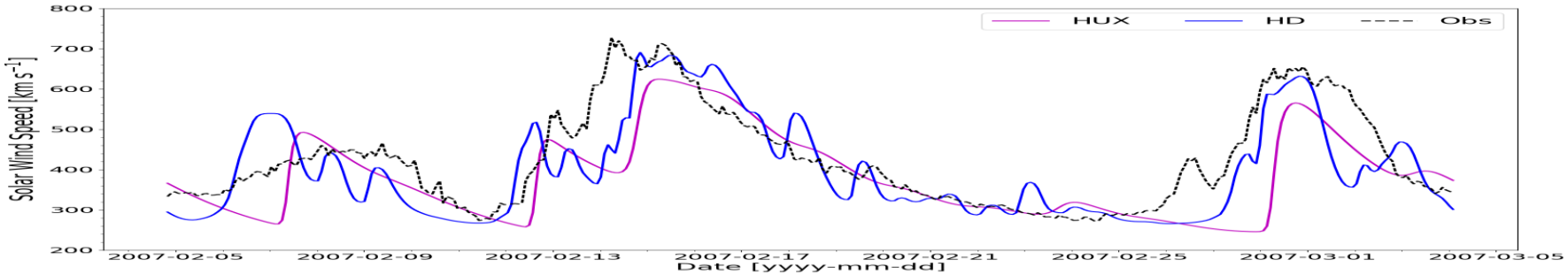


$$f_s = \frac{B_r(1.0\ R_0)}{2.5^2\ B_r(2.5\ R_0)}$$

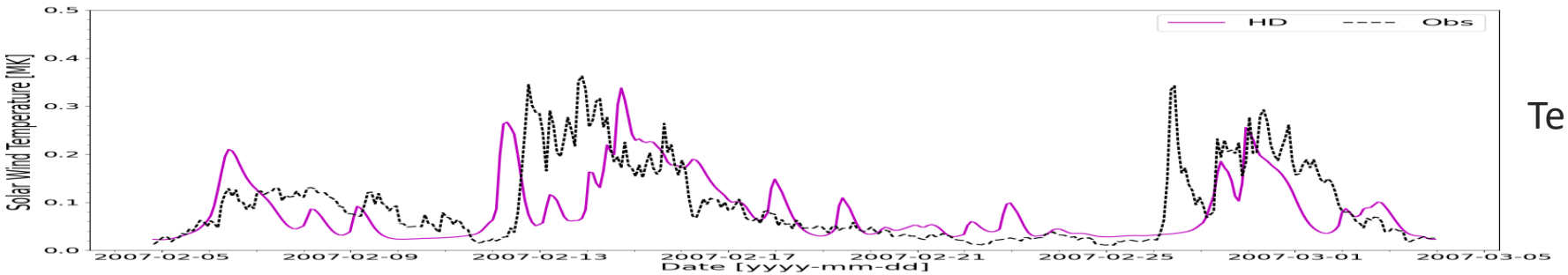
Model Outputs



CR 2053

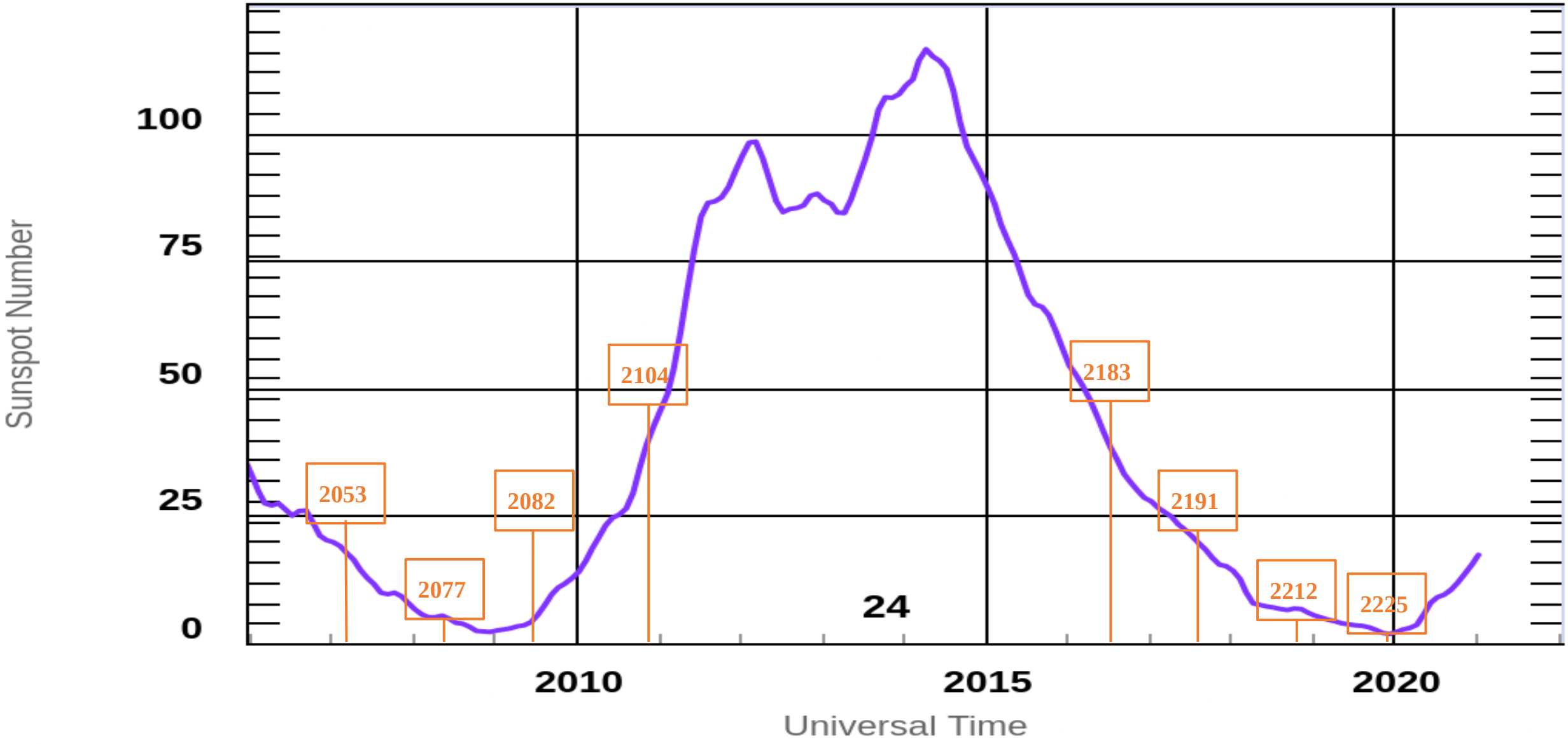


Speed Profile



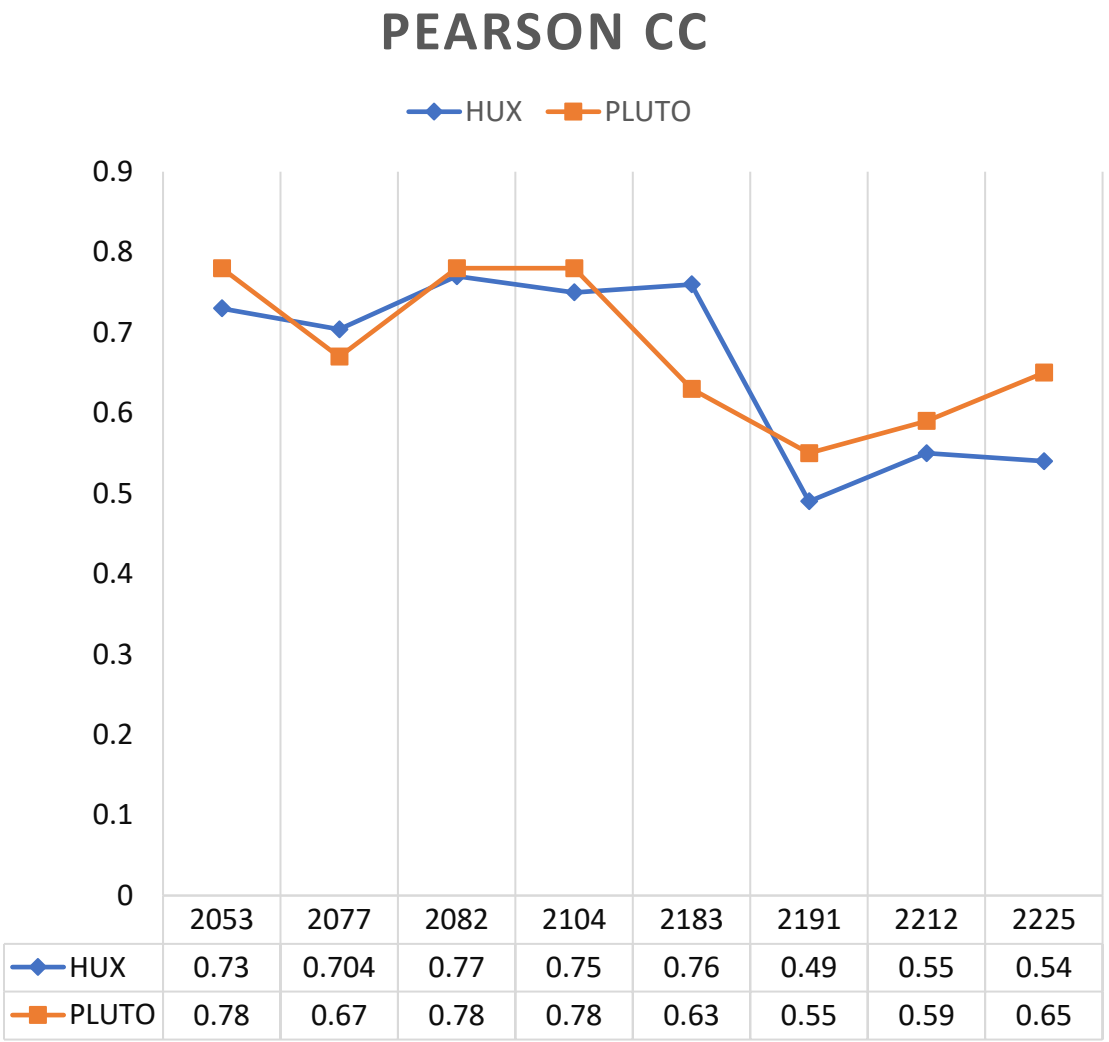
Temperature Profile

Sample CRs

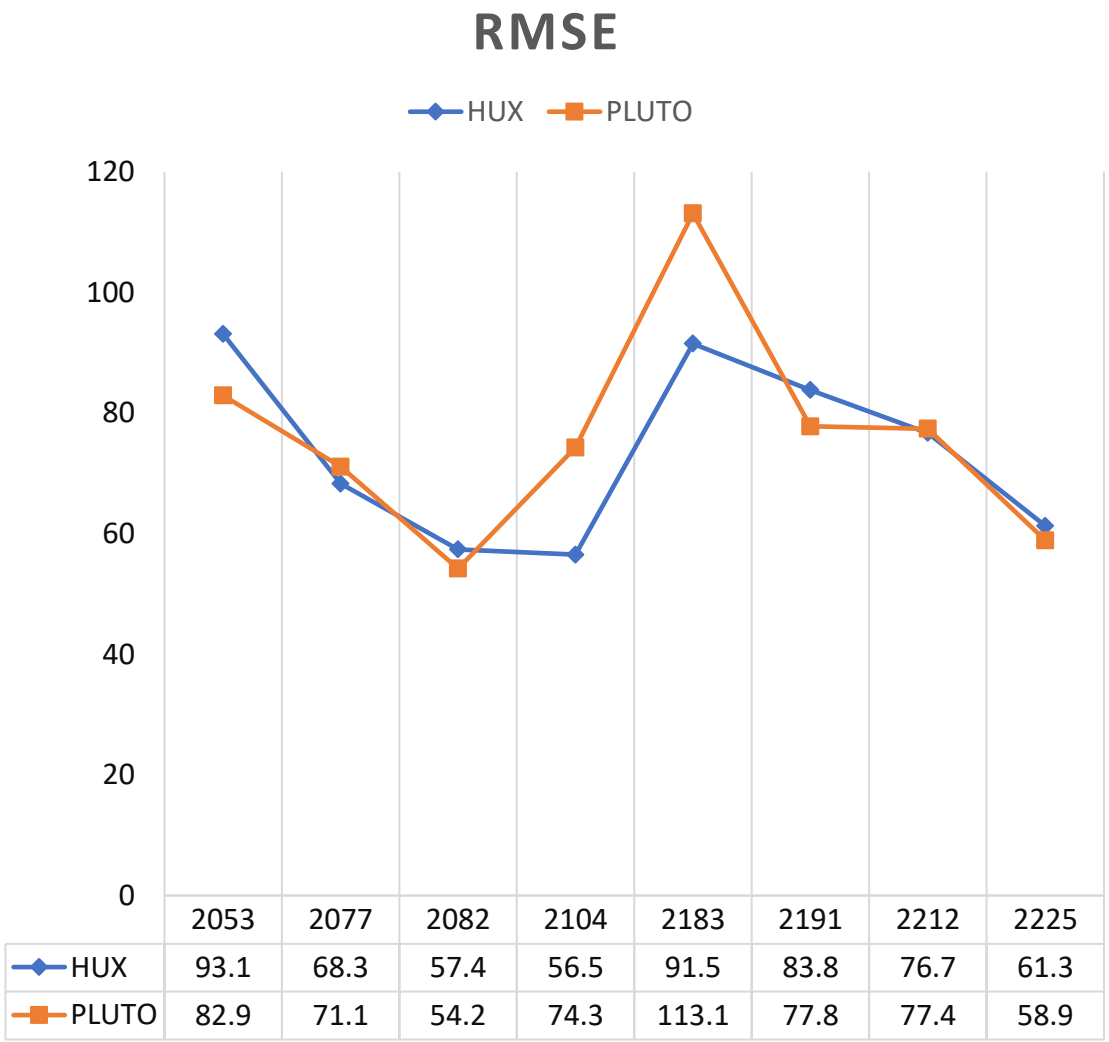

Sunspot Number
100
75
50
25
0
2053
2077
2082
2104
24
2183
2191
2212
2225
2010
2015
2020
Universal Time

Statistics

Solar Wind Speed (km/s)

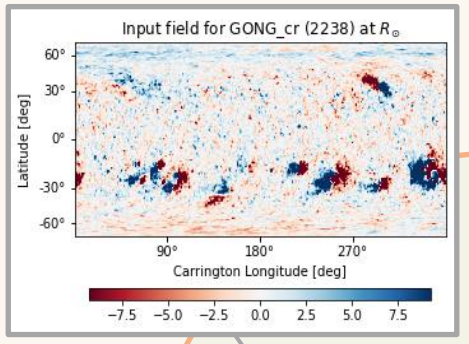


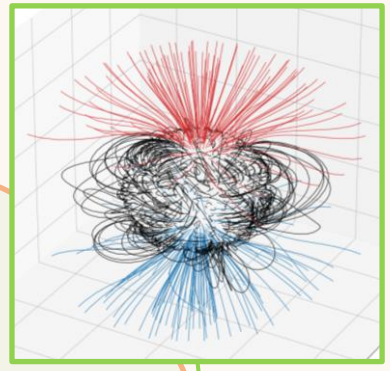
	2053	2077	2082	2104	2183	2191	2212	2225
HUX	0.73	0.704	0.77	0.75	0.76	0.49	0.55	0.54
PLUTO	0.78	0.67	0.78	0.78	0.63	0.55	0.59	0.65

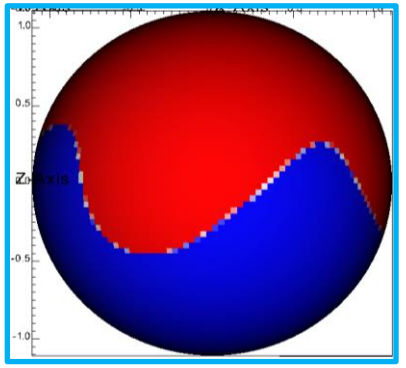


	2053	2077	2082	2104	2183	2191	2212	2225
HUX	93.1	68.3	57.4	56.5	91.5	83.8	76.7	61.3
PLUTO	82.9	71.1	54.2	74.3	113.1	77.8	77.4	58.9

Summary







GONG/HMI

PFSS

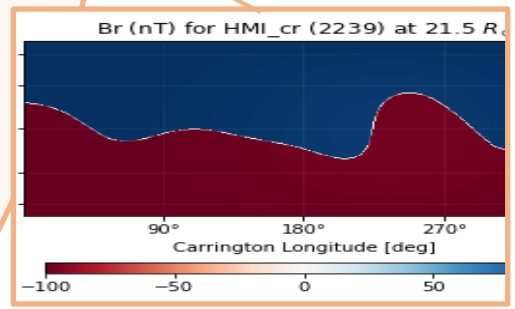
SCS

PLUTO (MHD)

PFSS-SCS boundary at 2.5 R_0

2.5 R_0

21.5 R_0



SOLAR WIND at L1

- Velocity (ASPEX)
- Magnetic Field (MAG)
- Temperature (ASPEX)
- Density (PAPA)