Proton and electron fluxes in the plasma sheet transition region and their dependence on solar wind parameters

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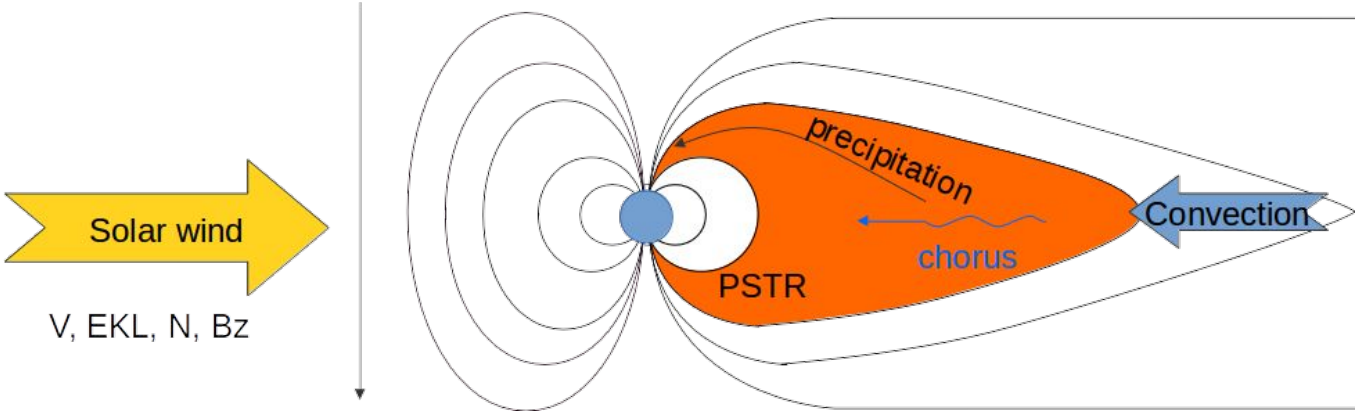
Outline

- Plasma sheet transition region (PSTR); 6 - 15 Re
  - The region between dipolar and tail like magnetic field configuration.
  - Initial particle population for radiation belts and ring current
  - Particle precipitation into the auroral ionosphere
- High energy tail in proton/electron spectra (>~95/31 keV)
  - Convection enhancements, wave-particle acceleration, burst bulk flows (BBF)
- Which solar wind parameters influence high energy ion/electron fluxes in PSTR the most?
- How it depends on region??
- Which time delays are involved? For different regions? species/energy?



Data (5m averages)

OMNI 2007-2019

- Vi, B, Ni, Ti, PD
- EKL = $-V*B_{yz}*\sin^2(\theta/2)*10^{-3}$
- VBn = $-V*B_{yz}*\cos^2(\theta/2)*10^{-3}$

Themis A, D, E 2007-2019:

- Spectra GMOM
- (i/e: 5/6 eV - 4MeV/700 keV)
- Proton/electron temperature (Ti/e)
- Proton fluxes at 95 and 140 keV (i95, i140)
- Electron fluxes at 31 and 93 keV (e31, e93)
- r, φ SM, dZns

Plasma sheet condition

$(R \leq 8Re \cap \text{dZns} < 1Re \cap Bxy < Bz) \cup (R > 8 \cap (\beta > 1 \cup Bxy < Bz))$

~2.3*105 data points

Regression analysis

$$O^* = const + \sum_{i=0}^{n} a_i I_i^*$$

regression equation: O*- logarithm of normalized output parameter, I_i*- logarithms of normalized predictors, a_i- regression coefficient

$$VIF = \frac{1}{1 - R^2}$$

VIF detects multicollinearity in the set of predictors;
VIF = 1: predictor does not correlate with other predictors;
VIF > 5: predictor correlate with other predictors;

Correction of the predictors set

To minimize multicollinearity in the predictors matrix we calculate VIF for each parameter and then exclude the parameter with maximum VIF. We repeat this process for resulting predictors set until only SM coordinates are left.

- Full set of the parameters, highest CC, PE, vif up to 82.
- Optimal set, CC, PE unchanged, vif < 2.46
- No sw parameters, CC, PE strongly decrease

We will use the optimal set in further analysis.

	Iteration	1	15	30
	inputs del./avg hr	Variance inflation factor		
Solar wind	Vx 0.5/0.5	4.46	2.23	x
	N 0/0.5	48.77	2.36	x
	N 0.5/0.5	81.3	x	x
	N 1/1	55.81	x	x
	N 2/2	34.61	x	x
	N 4/4	19.86	2.71	x
	N 8/8	13.08	x	x
	N 16/8	7.07	1.45	x
	Pd 0/0.5	31.98	x	x
	Pd 0.5/0.5	48.74	x	x
	Pd 1/1	37.14	x	x
	Pd 2/2	26.37	2.92	x
	Pd 4/4	15.56	x	x
	Pd 8/8	10.93	x	x
	Pd 16/8	7.09	x	x
	EKL 0/0.5	4.73	x	x
	EKL 0.5/0.5	6.44	1.74	x
	EKL 1/1	5.03	x	x
	EKL 2/2	3.88	2.23	x
	EKL 4/4	3.15	2.69	x
	EKL 8/8	2.62	2.35	x
	EKL 16/8	1.9	1.64	x
	NBL 0/0.5	5.73	2.22	x
	NBL 0.5/0.5	7.98	x	x
	NBL 1/1	6.01	2.44	x
	NBL 2/2	4.22	x	x
	NBL 4/4	2.99	2.38	x
	NBL 8/8	2.21	2.34	x
	NBL 16/16	1.65	1.65	x
SM	r	1.02	1.02	1.01
	Ion	1.04	1.04	1.01
		correlation		
	Electron temperature	0.75	0.73	0.54
	Electron 31 keV	0.83	0.83	0.62
	Electron 93 keV	0.89	0.89	0.77
	Ion temperature	0.54	0.53	0.3
	Ion 95 keV	0.8	0.79	0.7
	Ion 140 keV	0.85	0.85	0.77
		Prediction efficiency		
	Electron temperature	0.58	0.55	0.32
	Electron 31 keV	0.69	0.69	0.42
	Electron 93 keV	0.81	0.79	0.62
	Ion temperature	0.31	0.3	0.12
	Ion 95 keV	0.64	0.63	0.49
	Ion 140 keV	0.73	0.73	0.61

Full model (6 -12 Re; all MLTs)

- **Electrons**: largest impact correspond to **Vsw** and **EKL** (at ~2 hrs delay for 31 keV and 8 hrs delay for 93 keV).
  CC= 0.73(Te), 0.83(31keV), 0.89(93keV)
- **Protons**: largest impact correspond to **Vsw**, and **Pd** with 2 hrs delay . EKL is less important
  CC= 0.53(Ti), 0.79(95keV), 0.85(140keV)
- Long IMF Bn (NBL) decreases fluxes of high energy electrons and protons

					Te		e. flux 31 keV		e. flux 93 keV		Ti		I. flux 95 keV		I. flux 140 keV	
	inputs del./avg	median	rms	vif	a	a*rms	a	a*rms	a	a*rms	a	a*rms	a	a*rms	a	a*rms
	const	0	0	0	0.03	/	0.07	/	-0.1	/	0.04	/	-0.33	/	-0.02	/
Solar wind	Vx 0.5/0.5	-400.85	0.22	2.2	1.69	0.37	2.55	0.56	2.97	0.65	0.20	0.04	5.34	1.17	5.45	1.20
Solar wind	N 0/0.5	3.92	0.64	1.92	0.10	0.06	0.08	0.05	0.04	0.03	-0.04	-0.03	-0.01	-0.01	0.10	0.06
Solar wind	N 4/4	3.94	0.63	2.46	0.04	0.03	-0.05	-0.03	-0.22	-0.14	-0.05	-0.03	-0.37	-0.23	-0.43	-0.27
Solar wind	N 8/4	4.05	0.62	1.71	-0.04	-0.02	-0.07	-0.04	-0.21	-0.13	0.00	0.00	0.03	0.02	-0.30	-0.19
Solar wind	Pd 2/2	1.39	0.53	2.45	0.06	0.03	-0.09	-0.05	-0.10	-0.05	0.07	0.04	0.51	0.27	0.24	0.13
Solar wind	Ekl 0.5/0.5	0.58	1.49	1.77	0.09	0.13	0.02	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03
Solar wind	EKL 2/2	0.6	1.21	2.32	0.20	0.24	0.14	0.17	0.11	0.13	0.07	0.08	0.14	0.17	0.11	0.13
Solar wind	EKL 4/4	0.61	1.07	2.8	0.10	0.11	0.16	0.17	0.15	0.16	0.06	0.06	0.02	0.02	0.04	0.04
Solar wind	EKL 8/8	0.63	0.93	2.44	0.05	0.05	0.17	0.16	0.21	0.20	0.01	0.01	0.04	0.04	0.06	0.06
Solar wind	EKL 16/8	0.64	0.96	1.7	0.05	0.05	0.11	0.11	0.15	0.14	-0.01	-0.01	-0.16	-0.15	-0.04	-0.04
Solar wind	NBL 0/0.5	0.57	1.37	2.2	-0.03	-0.04	-0.02	-0.03	-0.02	-0.03	-0.01	-0.01	-0.04	-0.05	-0.01	-0.01
Solar wind	NBL 1/1	0.56	1.29	2.34	-0.14	-0.18	-0.14	-0.18	-0.11	-0.14	-0.04	-0.05	-0.18	-0.23	-0.13	-0.17
Solar wind	NBL 4/4	0.57	1.06	2.17	-0.06	-0.06	-0.12	-0.13	-0.10	-0.11	-0.02	-0.02	-0.13	-0.14	-0.10	-0.11
Solar wind	NBL 8/8	0.57	0.94	2.06	-0.03	-0.03	-0.08	-0.08	-0.10	-0.09	-0.01	-0.01	-0.22	-0.21	-0.16	-0.15
Solar wind	NBL 16/8	0.59	0.96	1.51	-0.01	-0.01	-0.01	-0.01	-0.05	-0.05	-0.01	-0.01	-0.28	-0.27	-0.23	-0.22
SM	r	9.37	0.21	1.02	1.86	0.39	-5.04	-1.06	-8.55	-1.80	0.24	0.05	-11.7	-2.46	-13.9	-2.91
SM	lon	181.2	0.32	1.04	1.71	0.55	0.67	0.21	0.48	0.15	-0.29	-0.09	-0.79	-0.25	-0.63	-0.20
	num	0	0	0	231294		234726		233939		246457		225687		225516	
	CC	0	0	0	0.73		0.83		0.89		0.53		0.79		0.85	
	PE	0	0	0	0.55		0.69		0.79		0.3		0.63		0.73	

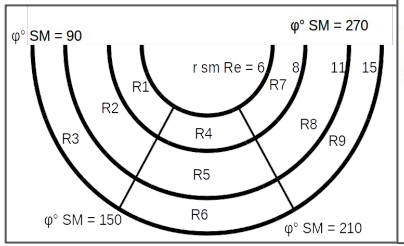
*Median, rms and vif of each SW parameter; a - coefficients of regression models, a*rms - product of rms and regression coefficient, representing weight of each predictor in the model; num - number of points in regression analysis; CC and PE - correlation coefficient and prediction efficiency correspondingly.*

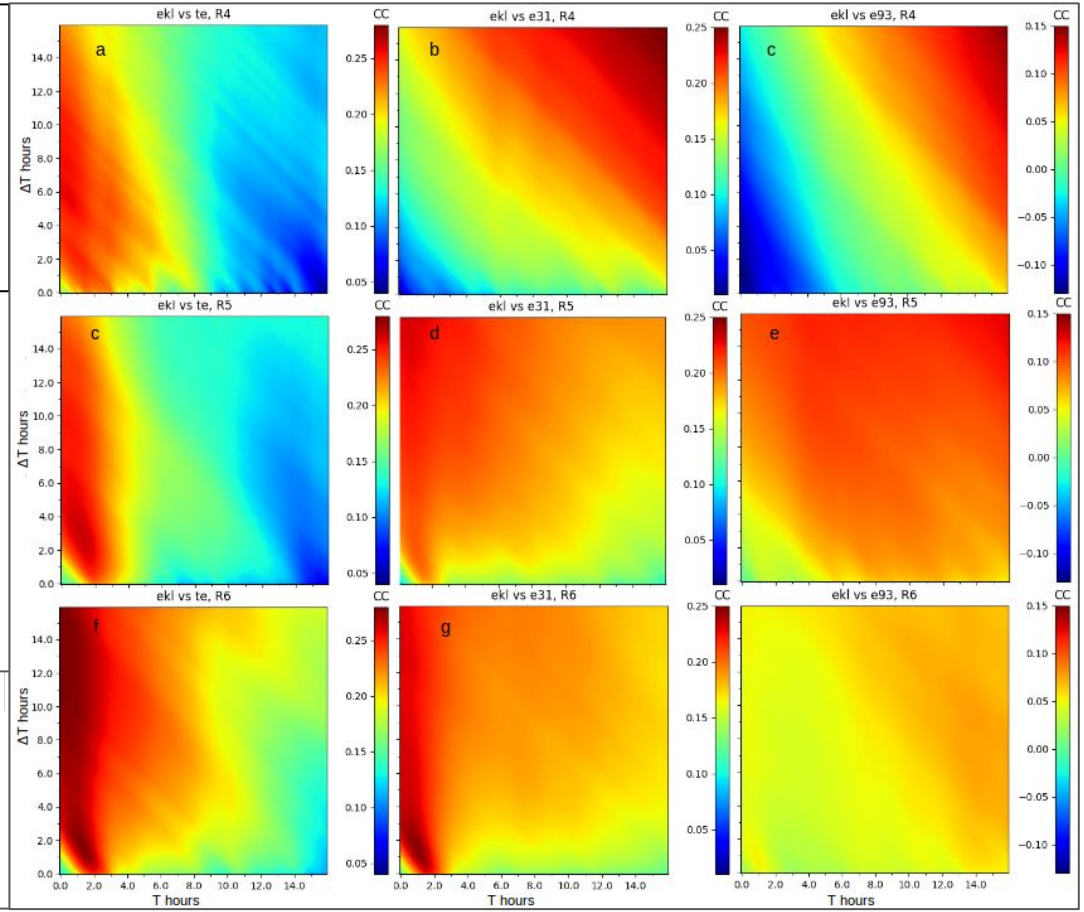
EKL influence on the plasma sheet parameters

*Each point on the plot shows the color- coded **correlation coefficient**, between plasma sheet parameters (Te, e31, e93) at time T0 and solar wind EKL parameter averaged for the time period between T0 - T and T0 - (T + □T). Both the **delay of time window (T) and its width (□T)** are varied to identify their optimal values. **Different plots** correspond to **different plasma sheet regions** (see the scheme below).*

RESULTS

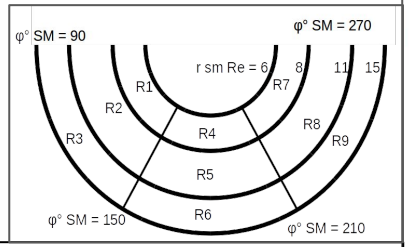
- The max correlation is observed within 2 hrs delay for Te, and at larger delays for the 31 keV and 93 keV fluxes.
- Largest time delay corresponds to the near Earth region.

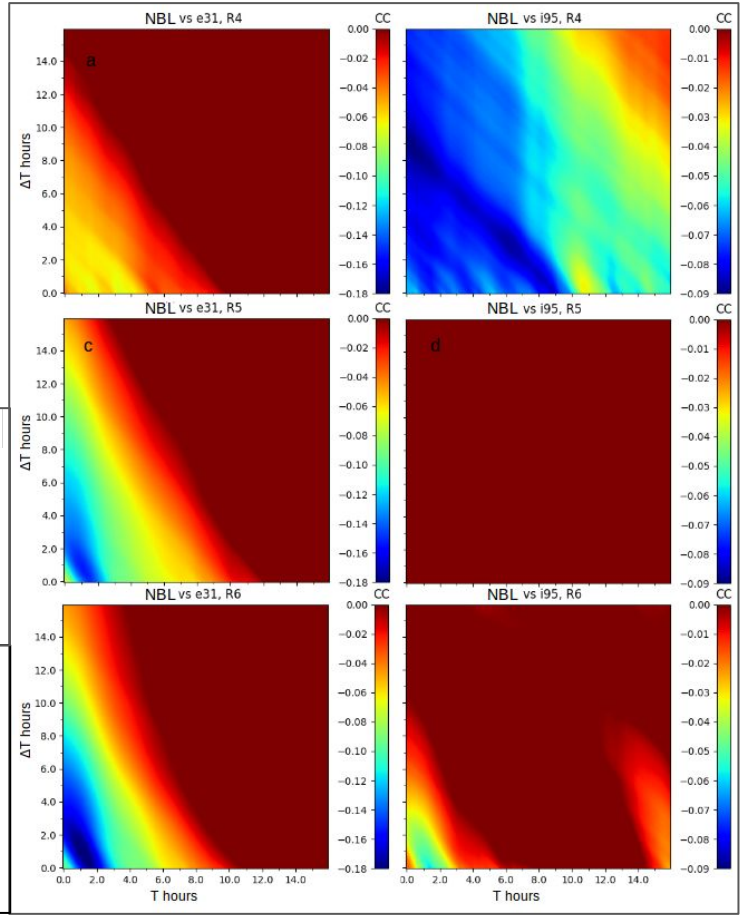




LBN influence on the plasma sheet parameters

- Highest negative correlation for the electron 31 keV fluxes are at the R5 and R6 region, correspond to delays 1-2 hours
- Highest negative correlation for the proton 95 keV fluxes are at the R4 region, correspond to delays 1-10 hours.





*Each point on the plot shows the color- coded **correlation coefficient**, between plasma sheet parameters (e31, i95) at time T0 and solar wind EKL parameter averaged for the time period between T0 - T and T0 - (T + □T). Both the **delay of time window (T) and its width (□T)** are varied to identify their optimal values. **Different plots** correspond to **different plasma sheet regions** (see the scheme below).*

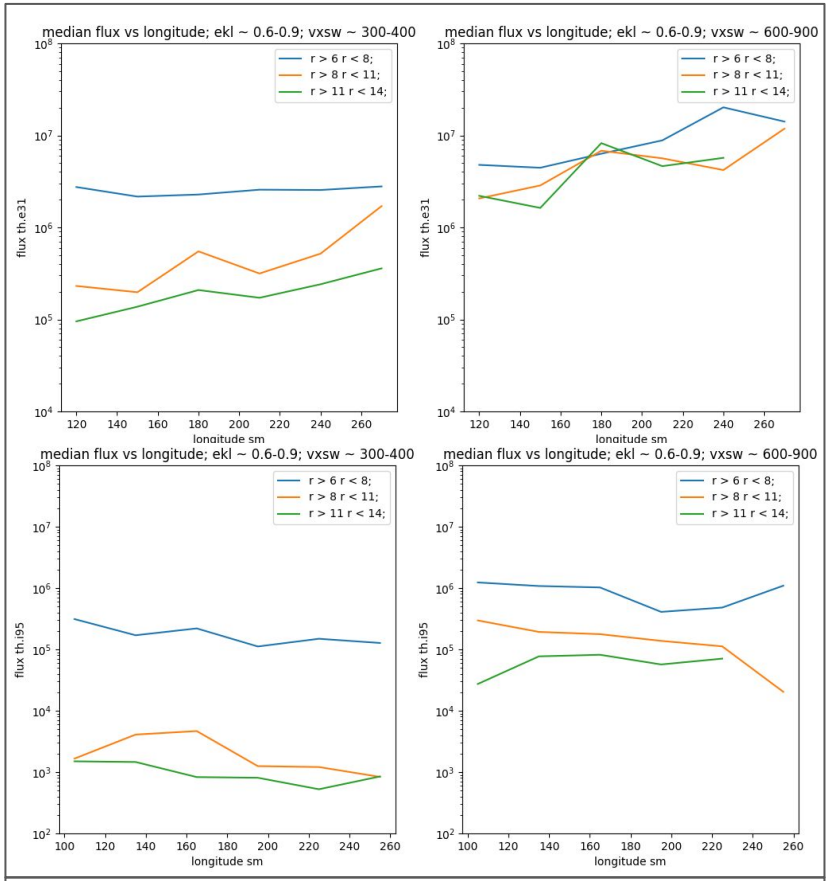
Vsw influence on plasma sheet parameters

To illustrate the character of SW velocity impact we plot proton/electron fluxes against SM longitude separately for different radial distances for low/high Vsw intervals (EKL was the same in both groups).

- e fluxes (p-fluxes) increase toward dawn (dusk) as expected in the dawn-dusk E-field.
- The strongest Vsw related effects correspond to the most distant range (11 < r < 14), being ~1 order for electrons and 2 orders of magnitude for protons,

This shows that Vsw-related flux changes are, to a large extent, formed in the plasma sheet and, then, influence the inner magnetosphere

- The weakest enhancements are near Earth (6 < r < 8) (6 times for electrons and protons)

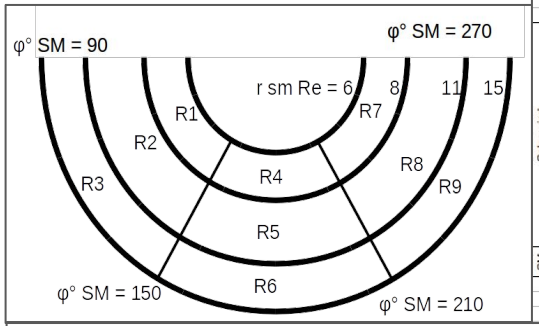


Median values of 31/93 keV electron fluxes and 95/140 keV proton fluxes at different longitude for two solar wind speed range and same ekl range.

Region-binned model

- Vsw impact is stronger on the dawnside for electrons, and on the dusk side for protons; The strongest impact for e31/93 & i95/140 is observed near the midnight;
- EKL impact includes a longer delay for the electrons closer to the earth;
- BNL effect remains in the binned model;

		Electron temperature									Ion temperature								
	inputs del/avg hr.	R1	R2	R3	R4	R5	R6	R7	R8	R9	R1	R2	R3	R4	R5	R6	R7	R8	R9
Solar wind	Vx 0.5/0.5	0.18	0.54	0.61	0.41	0.34	0.31	0.39	0.17	0.01	0.06	0.10	0.11	0.07	0.10	0.15	0.07	-0.01	-0.11
	N 0/0.5	-0.15	0.28	0.49	-0.06	0.04	0.10	0.10	0.00	-0.12	0.04	0.00	-0.03	0.04	0.02	-0.01	0.13	-0.01	-0.17
	N 4/4	-0.01	-0.01	0.12	0.14	0.03	-0.04	0.05	-0.03	-0.06	0.00	-0.04	-0.10	0.06	-0.02	-0.01	-0.01	-0.03	-0.04
	N 8/4	-0.07	0.01	0.03	-0.05	0.00	-0.02	-0.03	-0.04	-0.06	0.04	0.01	-0.01	0.01	0.00	-0.02	0.03	0.00	0.00
	Pd 2/2	0.11	0.02	0.01	0.04	0.01	-0.05	0.06	0.01	0.06	0.03	0.01	-0.02	-0.01	0.03	0.02	0.01	0.05	0.10
	Ekl 0.5/0.5	0.07	0.15	0.07	0.19	0.15	0.15	0.18	0.10	0.04	0.01	-0.01	-0.01	0.01	0.01	0.01	0.00	0.03	0.01
	EKL 2/2	0.13	0.21	0.12	0.39	0.23	0.27	0.44	0.29	0.22	0.06	0.07	0.10	0.05	0.08	0.13	0.00	0.06	0.10
	EKL 4/4	0.13	0.07	0.17	0.12	0.09	0.04	0.10	0.14	0.12	0.02	0.06	0.13	0.05	0.04	0.09	0.04	0.07	0.05
	EKL 8/8	0.06	0.06	-0.01	0.04	0.02	0.00	0.06	0.06	0.08	0.00	-0.01	0.08	0.02	-0.02	-0.02	0.03	0.03	0.04
	EKL 16/8	0.04	0.08	0.09	0.07	0.01	0.02	0.10	0.05	0.01	-0.01	0.00	-0.02	-0.02	-0.02	-0.01	0.03	0.00	-0.03
	NBL 0/0.5	-0.01	0.04	-0.03	-0.04	-0.07	-0.05	-0.07	-0.07	-0.05	0.00	-0.01	-0.03	-0.01	-0.01	-0.01	0.01	0.00	0.00
	NBL 1/1	-0.14	-0.15	-0.06	-0.30	-0.19	-0.14	-0.20	-0.15	-0.13	-0.04	-0.04	-0.05	-0.04	-0.04	-0.06	0.00	-0.04	-0.06
	NBL 4/4	-0.05	-0.05	-0.05	-0.02	-0.06	-0.03	-0.12	-0.05	-0.06	-0.02	-0.04	-0.05	0.01	-0.02	-0.03	0.00	0.00	-0.04
	NBL 8/8	0.05	0.02	-0.05	0.00	-0.04	-0.03	-0.06	-0.05	-0.02	0.02	-0.03	0.00	-0.01	0.00	0.00	0.00	-0.01	0.02
	NBL 16/8	-0.07	0.00	0.08	0.03	-0.02	0.03	0.02	0.01	0.00	-0.02	-0.01	-0.02	0.00	0.00	0.00	0.04	0.01	-0.01
	r	0.01	0.75	0.45	0.58	0.18	0.24	0.71	0.04	0.02	0.29	-0.04	-0.48	0.23	0.00	-0.31	0.31	0.06	-0.34
SM	lon	0.31	0.85	0.91	0.86	0.39	0.35	-0.52	-0.34	-0.12	0.05	0.00	0.00	-0.17	-0.12	-0.13	-0.32	-0.29	-0.38
	num	33886	32393	14838	35604	36022	12317	33549	45898	24935	16681	42377	19092	12642	33226	16219	17000	57751	31469
	CC	0.52	0.67	0.7	0.7	0.7	0.79	0.75	0.72	0.74	0.53	0.6	0.75	0.54	0.57	0.72	0.56	0.5	0.54
	PE	0.27	0.46	0.5	0.49	0.51	0.63	0.58	0.54	0.55	0.3	0.38	0.59	0.3	0.34	0.54	0.33	0.26	0.32
		Electron fluxes 31 keV									Ion fluxes 95 keV								
	inputs del/avg hr.	R1	R2	R3	R4	R5	R6	R7	R8	R9	R1	R2	R3	R4	R5	R6	R7	R8	R9
Solar wind	Vx 0.5/0.5	0.25	0.57	0.65	0.40	0.74	1.02	0.48	0.58	0.58	0.64	1.41	1.61	0.68	1.51	2.15	0.55	1.10	1.09
	N 0/0.5	-0.02	0.07	-0.01	0.04	0.08	0.19	0.06	0.15	0.13	-0.19	0.15	0.17	0.03	0.03	0.28	-0.19	0.18	0.10
	N 4/4	0.01	-0.14	-0.06	-0.03	-0.05	-0.11	0.04	-0.20	-0.13	-0.30	0.07	0.14	-0.29	-0.17	-0.01	-0.21	-0.20	-0.30
	N 8/4	-0.04	-0.04	-0.08	-0.02	-0.07	0.03	0.02	0.04	-0.01	-0.26	0.09	0.38	-0.18	0.05	0.45	-0.25	0.04	0.24
	Pd 2/2	-0.03	-0.08	0.01	0.00	-0.03	-0.04	0.03	0.04	0.03	0.27	0.24	0.36	0.08	0.24	0.09	0.01	0.09	0.39
	Ekl 0.5/0.5	-0.04	-0.03	0.03	0.04	0.13	0.18	0.13	0.10	0.10	-0.06	0.07	0.03	0.00	0.07	0.00	-0.06	-0.13	-0.04
	EKL 2/2	0.10	0.15	0.21	0.06	0.12	0.23	0.11	0.25	0.24	-0.02	0.21	0.42	-0.08	0.18	0.19	-0.04	0.19	0.23
	EKL 4/4	0.04	0.15	0.15	0.07	0.22	0.18	0.09	0.14	0.22	0.05	-0.05	-0.03	-0.06	0.04	-0.06	0.00	-0.05	0.28
	EKL 8/8	0.07	0.11	0.06	0.09	0.19	0.16	0.07	0.19	0.22	-0.26	-0.01	0.10	-0.07	0.01	-0.27	-0.04	0.30	0.27
	EKL 16/8	0.07	0.13	0.11	0.11	0.08	0.00	0.16	0.14	0.11	-0.12	-0.04	0.05	-0.10	-0.22	-0.31	-0.06	-0.08	-0.33
	NBL 0/0.5	0.01	0.04	-0.07	-0.01	-0.05	-0.08	-0.04	-0.05	-0.01	-0.05	-0.05	-0.20	-0.08	0.01	-0.12	-0.08	0.03	0.00
	NBL 1/1	0.01	-0.05	-0.08	-0.10	-0.34	-0.32	-0.15	-0.29	-0.29	-0.08	-0.29	-0.53	-0.04	-0.27	-0.30	-0.04	-0.17	-0.20
	NBL 4/4	-0.06	-0.11	-0.11	-0.03	-0.11	-0.17	-0.03	-0.11	-0.15	-0.11	-0.15	-0.19	-0.16	-0.02	-0.09	-0.06	-0.15	-0.06
	NBL 8/8	-0.01	-0.10	-0.13	-0.04	-0.04	-0.08	-0.03	-0.08	-0.15	-0.18	-0.15	0.11	-0.08	-0.19	-0.33	-0.11	-0.11	-0.07
	NBL 16/8	-0.01	0.02	0.05	-0.02	0.00	-0.04	-0.03	0.01	0.04	-0.05	-0.08	-0.27	-0.23	-0.12	-0.20	-0.23	-0.22	-0.28
SM	r	-0.56	-1.47	-1.10	-0.47	-1.18	0.37	-0.34	-1.48	-0.64	-2.93	-1.97	0.77	-2.82	-2.27	-2.17	-3.31	-1.65	-3.77
	lon	-0.03	-0.05	0.21	0.28	0.16	0.20	0.30	0.88	0.41	-0.04	0.14	0.23	-0.20	-0.76	-0.40	0.20	-0.24	-0.24
	num	34859	33083	14941	36606	36042	12304	33662	45953	25036	34764	32604	14580	36541	35144	11679	33434	43865	23829
	CC	0.63	0.8	0.72	0.6	0.77	0.79	0.68	0.8	0.76	0.79	0.63	0.55	0.72	0.63	0.59	0.75	0.55	0.52
	PE	0.4	0.64	0.52	0.36	0.59	0.64	0.48	0.64	0.58	0.63	0.39	0.31	0.53	0.4	0.35	0.58	0.3	0.28
		Electron fluxes 93 keV									Ion fluxes 140 keV								
	inputs del/avg hr.	R1	R2	R3	R4	R5	R6	R7	R8	R9	R1	R2	R3	R4	R5	R6	R7	R8	R9
Solar wind	Vx 0.5/0.5	0.33	0.70	0.89	0.42	0.75	1.10	0.39	0.66	0.78	0.66	1.13	1.42	0.80	1.41	1.99	0.71	1.16	1.18
	N 0/0.5	-0.06	-0.06	-0.06	0.04	0.08	0.19	-0.06	0.16	0.13	-0.21	-0.10	0.15	0.12	0.10	0.27	-0.15	0.26	0.19
	N 4/4	-0.07	-0.23	-0.13	-0.13	-0.13	-0.13	-0.04	-0.30	-0.16	-0.26	0.01	-0.04	-0.38	-0.28	-0.02	-0.17	-0.15	-0.25
	N 8/4	-0.16	-0.12	-0.15	-0.11	-0.18	0.05	-0.07	0.01	-0.02	-0.51	-0.16	0.13	-0.40	-0.20	0.24	-0.53	-0.13	0.05
	Pd 2/2	-0.02	-0.09	-0.02	-0.05	-0.07	-0.11	-0.02	0.02	0.06	0.16	0.19	0.36	-0.01	0.09	-0.05	-0.15	-0.10	0.31
	Ekl 0.5/0.5	-0.04	-0.06	0.01	0.00	0.04	0.16	0.00	0.03	0.12	-0.03	0.07	0.07	0.03	0.06	0.03	-0.03	-0.06	0.04
	EKL 2/2	0.02	0.16	0.27	0.00	0.08	0.16	0.02	0.18	0.17	-0.02	0.19	0.38	-0.07	0.08	0.19	-0.06	0.15	0.23
	EKL 4/4	0.04	0.15	0.06	0.00	0.20	0.20	0.06	0.12	0.26	0.02	-0.02	0.03	-0.11	0.10	-0.01	-0.03	-0.05	0.27
	EKL 8/8	0.04	0.14	0.09	0.10	0.23	0.20	0.07	0.30	0.34	-0.25	0.02	0.07	-0.06	0.04	-0.20	0.01	0.30	0.26
	EKL 16/8	0.09	0.19	0.20	0.10	0.13	0.12	0.14	0.17	0.12	-0.05	0.04	0.11	-0.03	-0.12	-0.12	-0.04	-0.03	-0.20
	NBL 0/0.5	0.03	0.11	-0.04	0.01	-0.03	-0.15	-0.03	-0.07	-0.04	-0.08	-0.01	-0.11	-0.05	0.03	-0.03	-0.11	-0.04	-0.03
	NBL 1/1	-0.04	-0.09	-0.08	-0.04	-0.22	-0.20	-0.03	-0.17	-0.23	-0.08	-0.24	-0.47	0.01	-0.18	-0.28	-0.01	-0.06	-0.10
	NBL 4/4	-0.03	-0.10	-0.07	-0.06	-0.14	-0.12	-0.03	-0.11	-0.15	-0.09	-0.05	-0.06	-0.18	0.07	0.06	-0.11	-0.09	-0.03
	NBL 8/8	-0.05	-0.13	-0.18	-0.05	-0.04	-0.15	-0.02	-0.08	-0.12	-0.20	-0.11	0.08	-0.08	-0.20	-0.31	-0.12	-0.06	-0.05
	NBL 16/8	-0.01	0.02	0.05	-0.04	0.01	-0.07	-0.09	-0.04	-0.05	-0.04	-0.06	-0.08	-0.26	-0.07	-0.19	-0.28	-0.28	-0.30
SM	r	-1.27	-2.32	-1.72	-1.24	-1.91	-0.24	-1.16	-1.88	-1.47	-3.74	-2.16	-0.63	-3.66	-2.50	-1.27	-4.16	-1.75	-2.64
	lon	-0.16	-0.21	0.29	0.06	0.01	0.22	0.35	0.42	0.05	-0.24	0.19	0.42	-0.23	-0.83	-0.46	0.18	-0.40	-0.12
	num	34924	33178	14966	36643	36109	12317	33700	46196	25170	34640	32079	14125	36423	34455	11431	33061	41924	23097
	CC	0.81	0.85	0.75	0.74	0.79	0.79	0.77	0.82	0.79	0.82	0.66	0.58	0.76	0.66	0.61	0.78	0.58	0.58
	PE	0.65	0.73	0.56	0.56	0.63	0.62	0.59	0.68	0.63	0.68	0.43	0.34	0.59	0.43	0.39	0.62	0.34	0.33



*Weight of each predictor (a*rms) for the models of plasma sheet parameters in the different sectors (see the scheme above)*

Conclusions

1. Solar wind drivers influence protons and electrons differently. Electrons are influenced similarly by solar wind speed and EKL, while protons mostly by solar wind speed and dynamic pressure, with smaller EKL impact.
2. Vsw-related flux changes are, to a large extent, formed in the plasma sheet and, then, influence the inner magnetosphere
3. EKL affect different parts of plasma sheet spectra with different time delay up to 24 hours for the fluxes in the high energy tail. The effect includes higher delay in the regions closer to Earth.
4. Timescales of the loss processes, during period of long Bn, can be estimated with NBL parameter. Protons stay longer in the magnetosphere (up to 24 hours) than electrons (2-4 hours) during absence of an energisation mechanism. Proton loss mostly take place at 6-8 Re. Electron loss mostly take place at 8-15 Re.

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