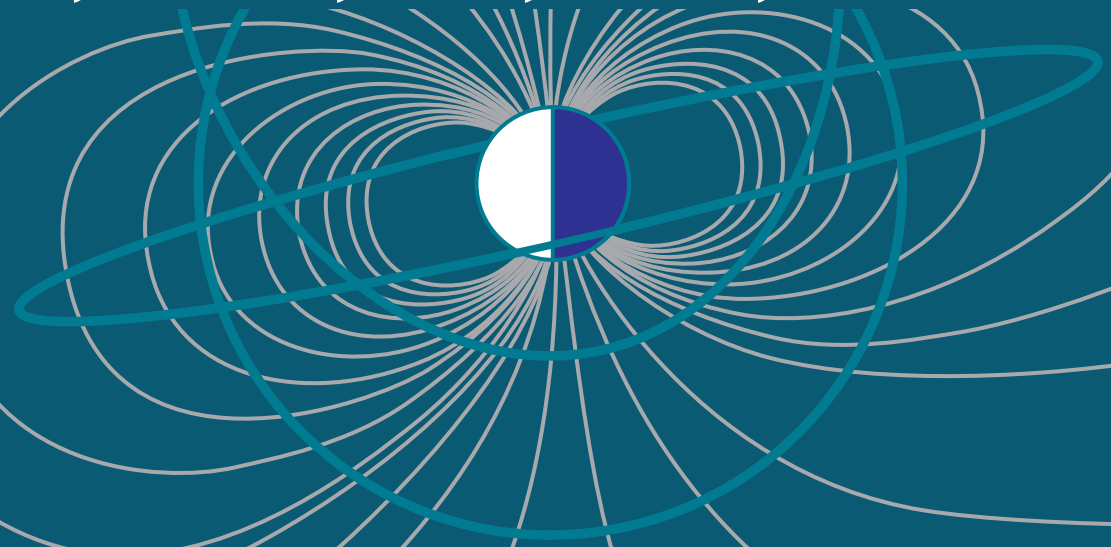
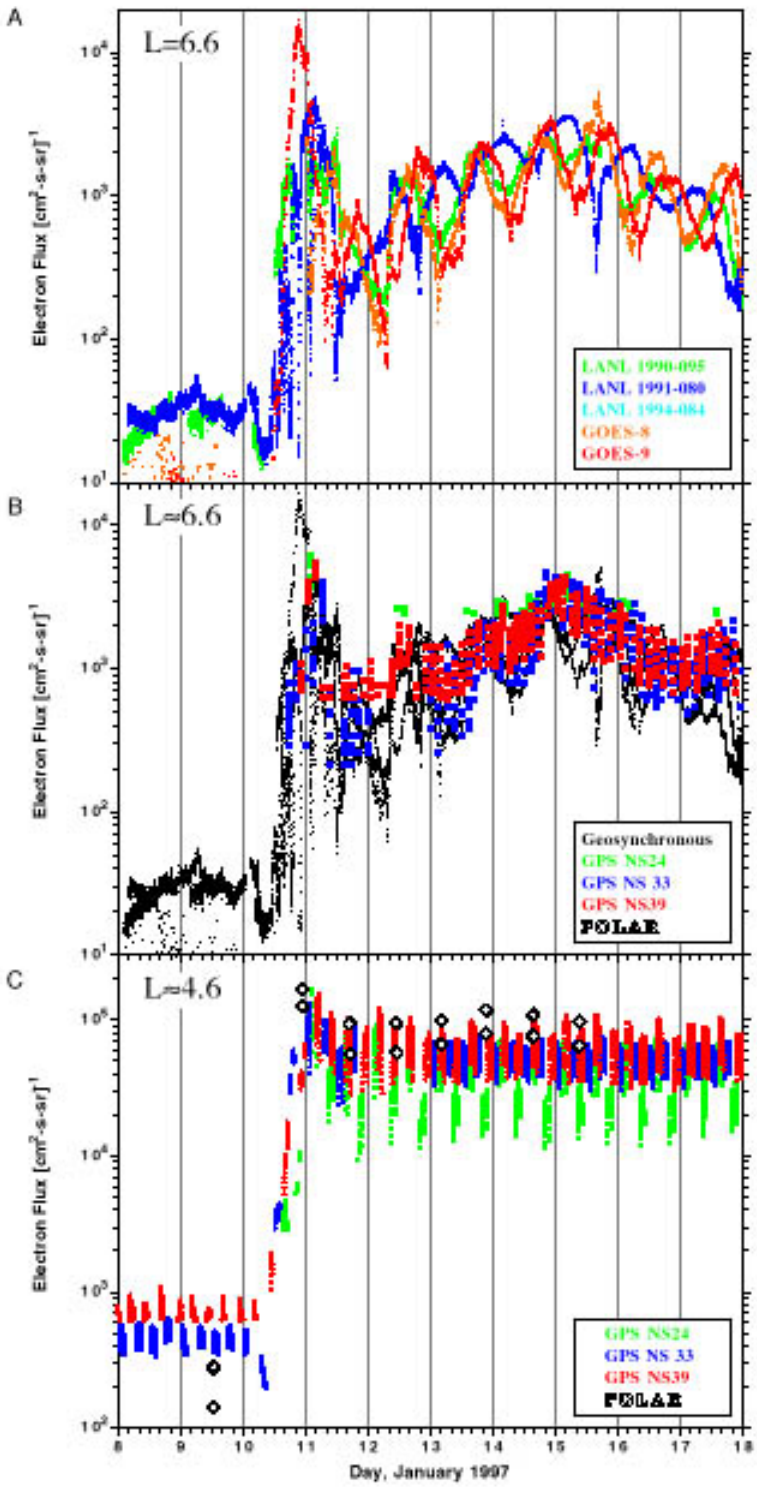
Relativistic Electron Observations in the Three-Dimensional Magnetosphere

Reeves, Cayton, Friedel, Henderson, Jahn, Meier, Baker, Kanekal, Blake, Fennell, and Selesnick



AGU Spring Meeting, Boston, MA, May 26-29, 1998

January 1997 Relativistic Electron Event as seen by LANL, GOES, GPS, & POLAR



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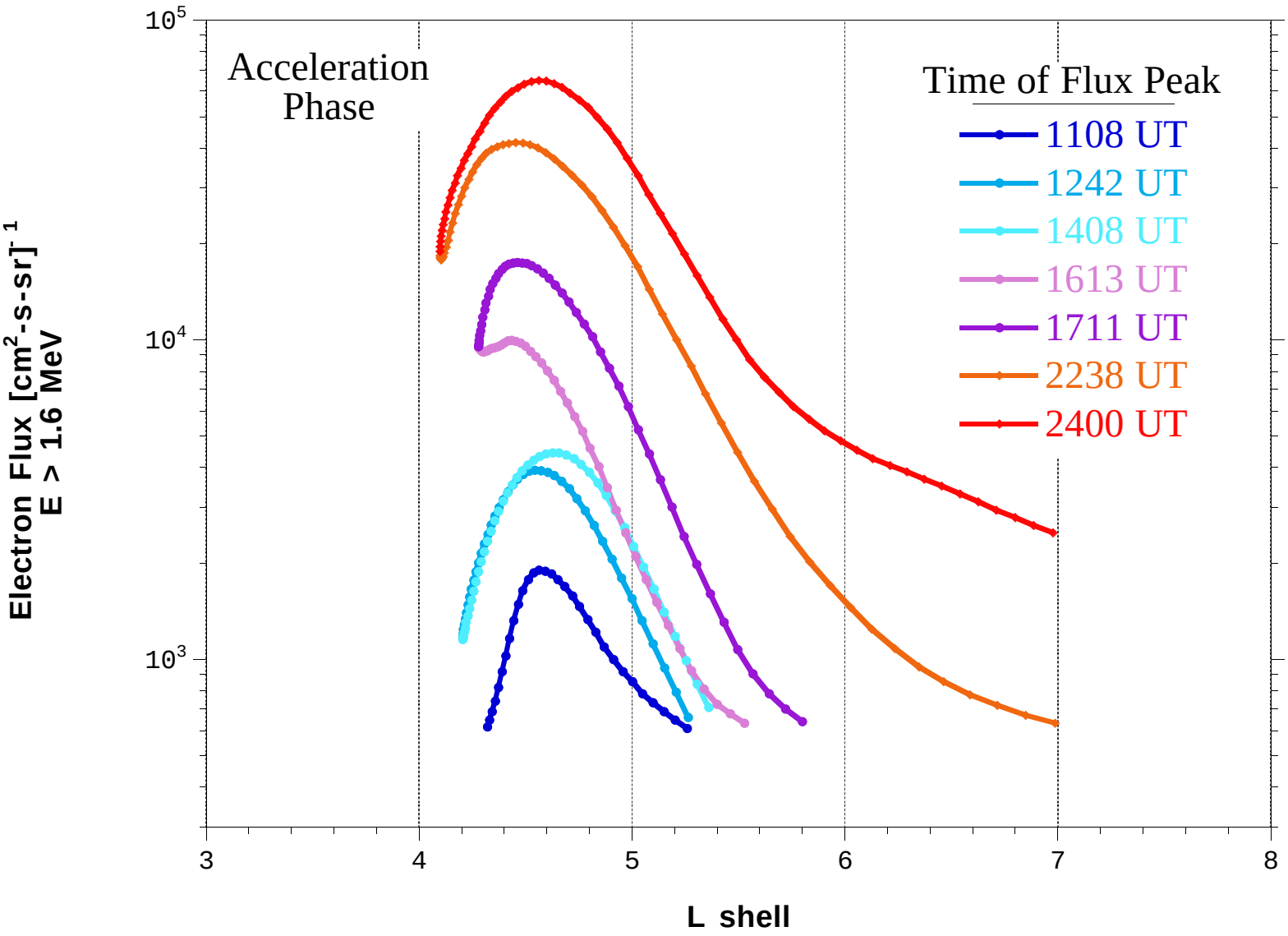
January 1997 Relativistic Electron Acceleration



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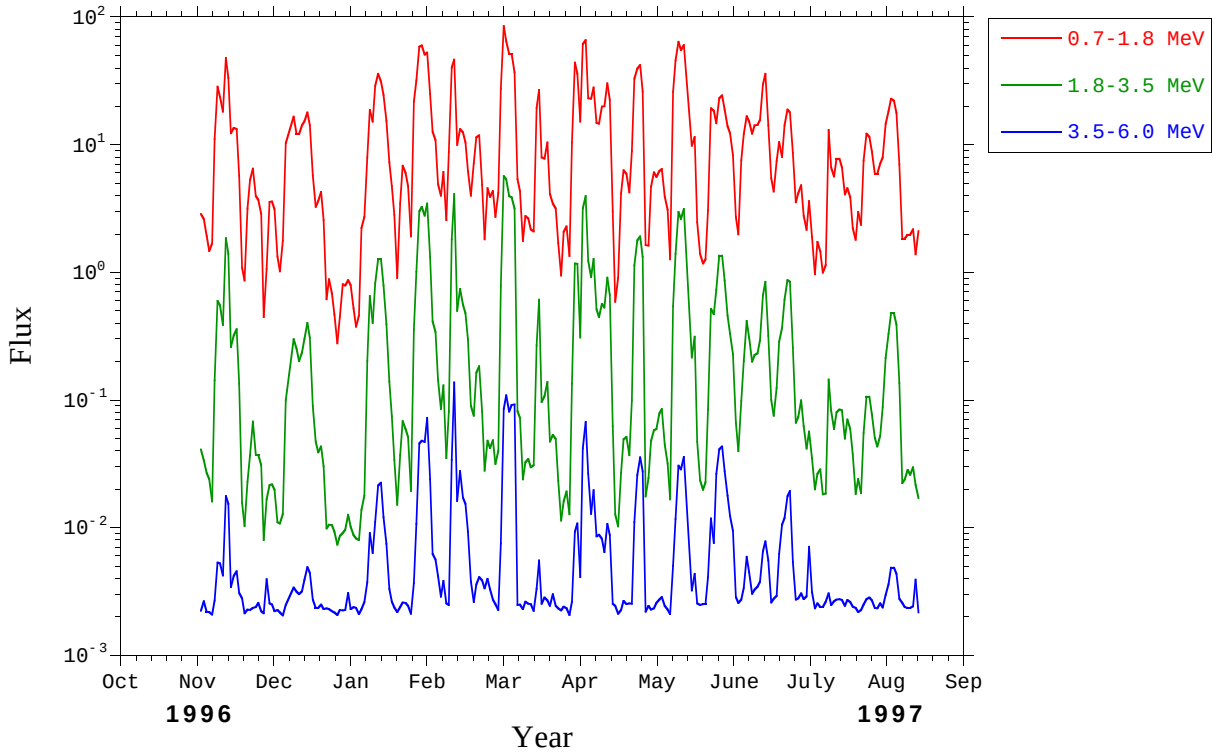
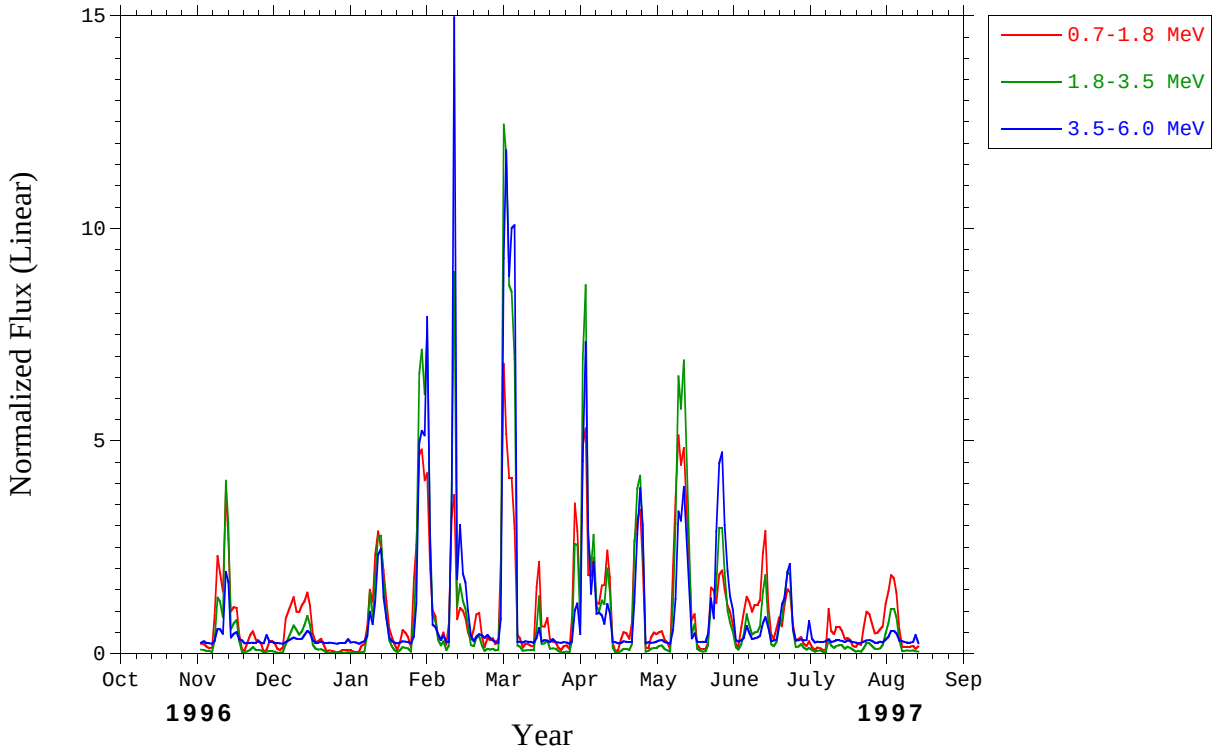
1991-080 ESP Daily Averages





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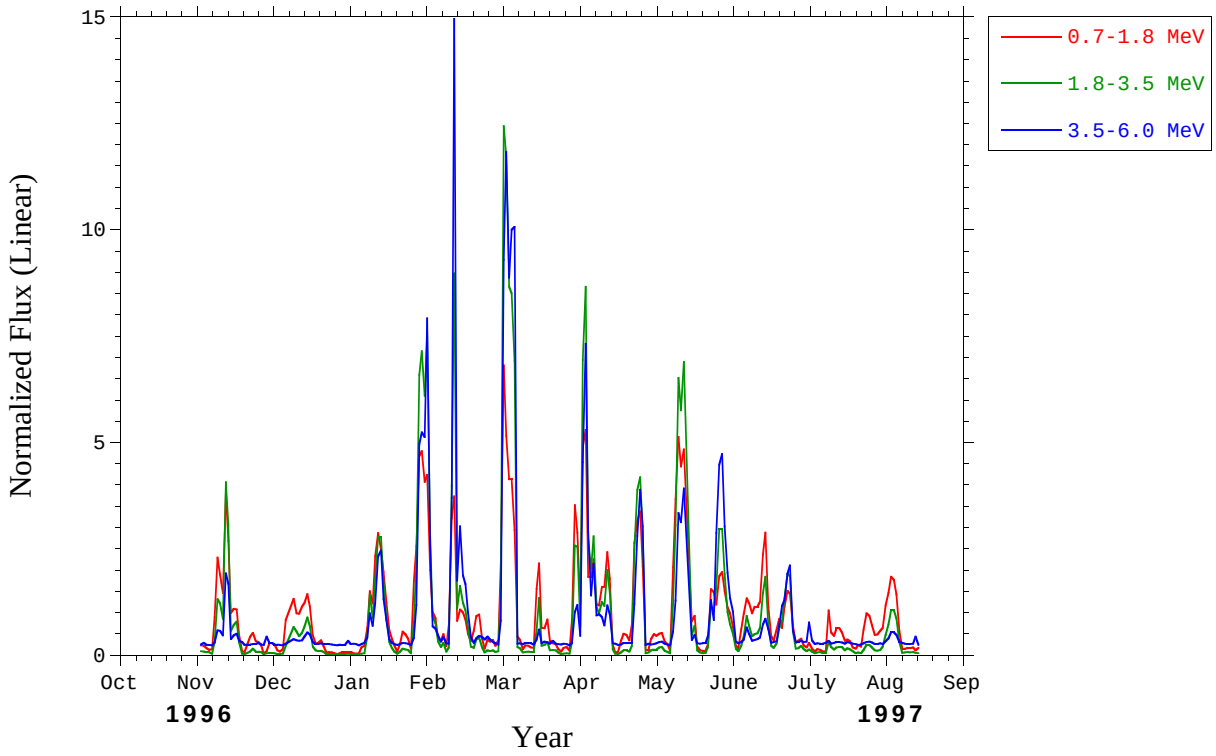
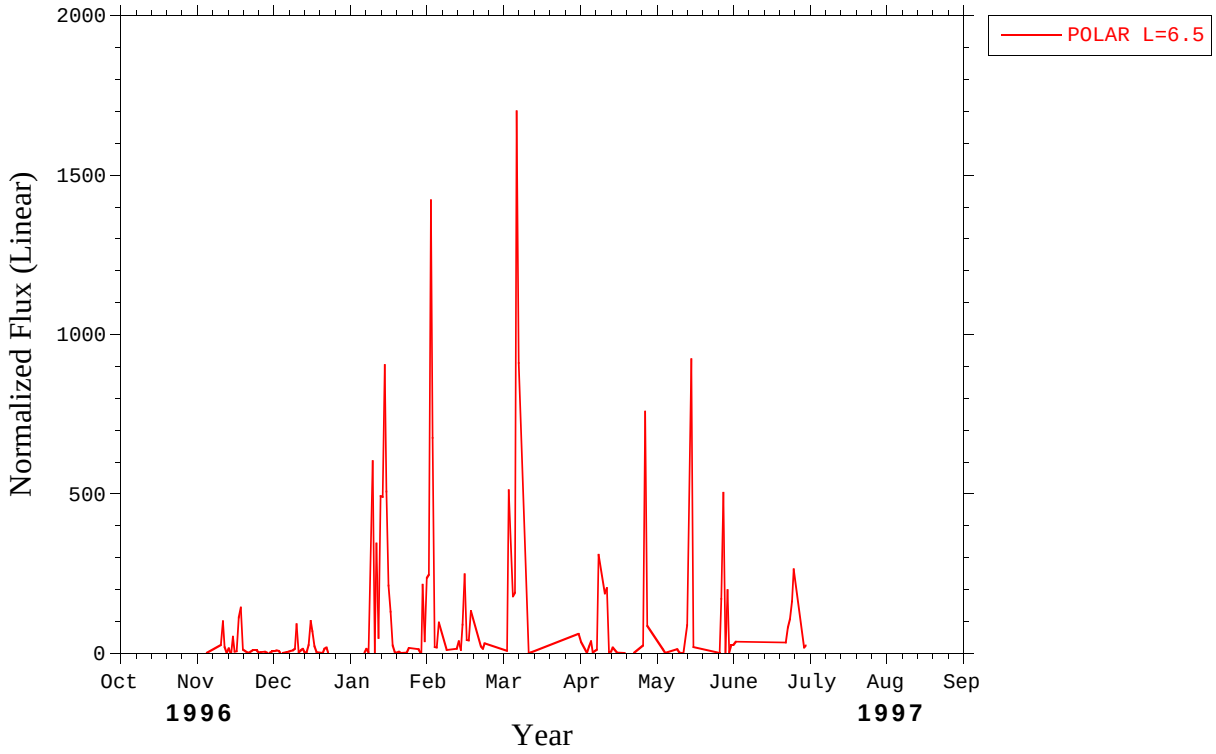
1991-080 ESP Daily Averages



POLAR @ L≈6.6



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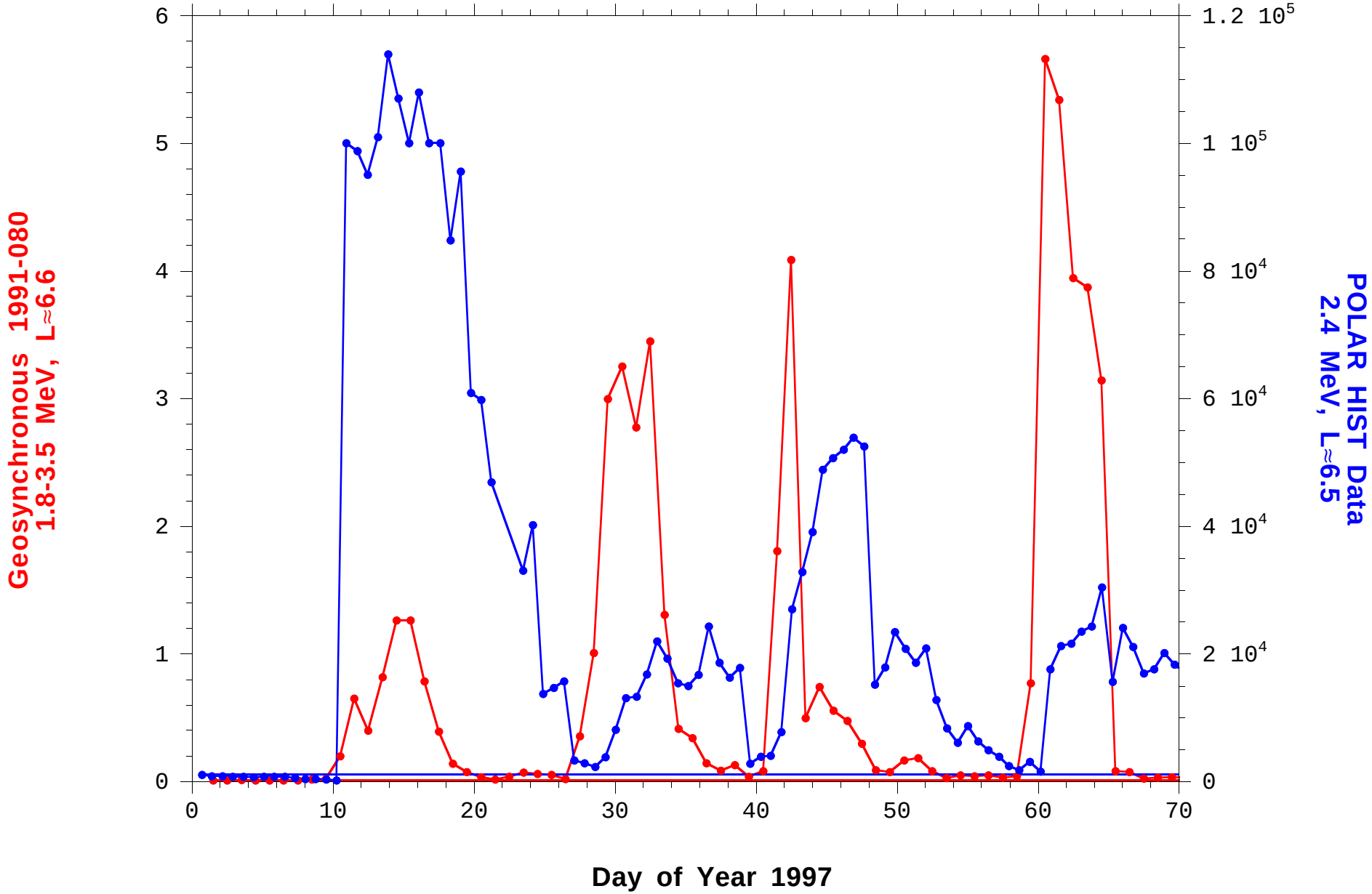
	Delta-Orbit	Delta-T (days)	L=3.5	L=3.7	L=3.9	L=4.1	L=4.3	L=4.5	L=4.7	L=4.9	L=5.5	L=6.5	L=7.5
0	-8	-5.92	6.2	5.7	19.3	43.5	49	38.9	37.6	32.6	4.5	6.7	3.2
1	-7	-5.18	8.7	9.0	25.1	49.0	56.7	51.1	49.6	45.9	10.5	1.1	2.8
2	-6	-4.44	11.2	15.7	31.9	50.1	59	57.3	55.5	54.8	18.3	3.9	3.9
3	-5	-3.7	12.8	18.9	33.9	48.2	58.5	62.7	61.0	59.7	30.0	12.8	13.4
4	-4	-2.96	14.4	23.3	36.0	45.8	58.7	67.3	67.9	68.6	43.7	23.5	15.3
5	-3	-2.22	16.1	28.7	36.2	44.5	57.9	65.8	68.6	74.4	56.9	29.9	28.4
6	-2	-1.48	17.9	30.6	35.1	40.7	56.1	66.9	73.7	79.0	70.1	40.4	22.9
7	-1	-0.74	18.8	31.4	33.5	30.2	47.2	63.3	73.6	81.8	81.4	50.9	34.6
8	0	0	14.9	29.6	26.5	19.1	39.5	60.0	73.1	87.3	100.0	72.5	46.0
9	1	0.74	18.3	24.8	20.2	9.2	27.3	46.8	61.1	75.4	81.4	59.8	33.6
10	2	1.48	24.6	17.7	9.7	0.5	16.8	33.9	45.8	60.3	70.1	45.4	39.4
11	3	2.22	23.1	13.6	0.5	2.0	12	28.4	35.7	41.4	56.9	37.7	21.3
12	4	2.96	13.6	5.7	6.5	4.6	2.9	15.8	18.5	28.2	43.7	34.0	15.1
13	5	3.7	9.3	0.8	8.1	5.5	0.6	3.0	4.1	7.3	30.0	24.8	7.4
14	6	4.44	3.8	4.3	10.3	6.7	4	1.7	1.2	4.8	18.3	15.4	1.2
15	7	5.18	1.4	8.1	10.1	8.6	6.5	5.7	3.0	1.7	10.5	11.2	0.6
16	8	5.92	1.3	8.8	10.1	8.1	8.8	7.5	5.7	2.6	4.5	11.2	7.1

POLAR @ L=4.1
Geosynchronous @ L≈6.6



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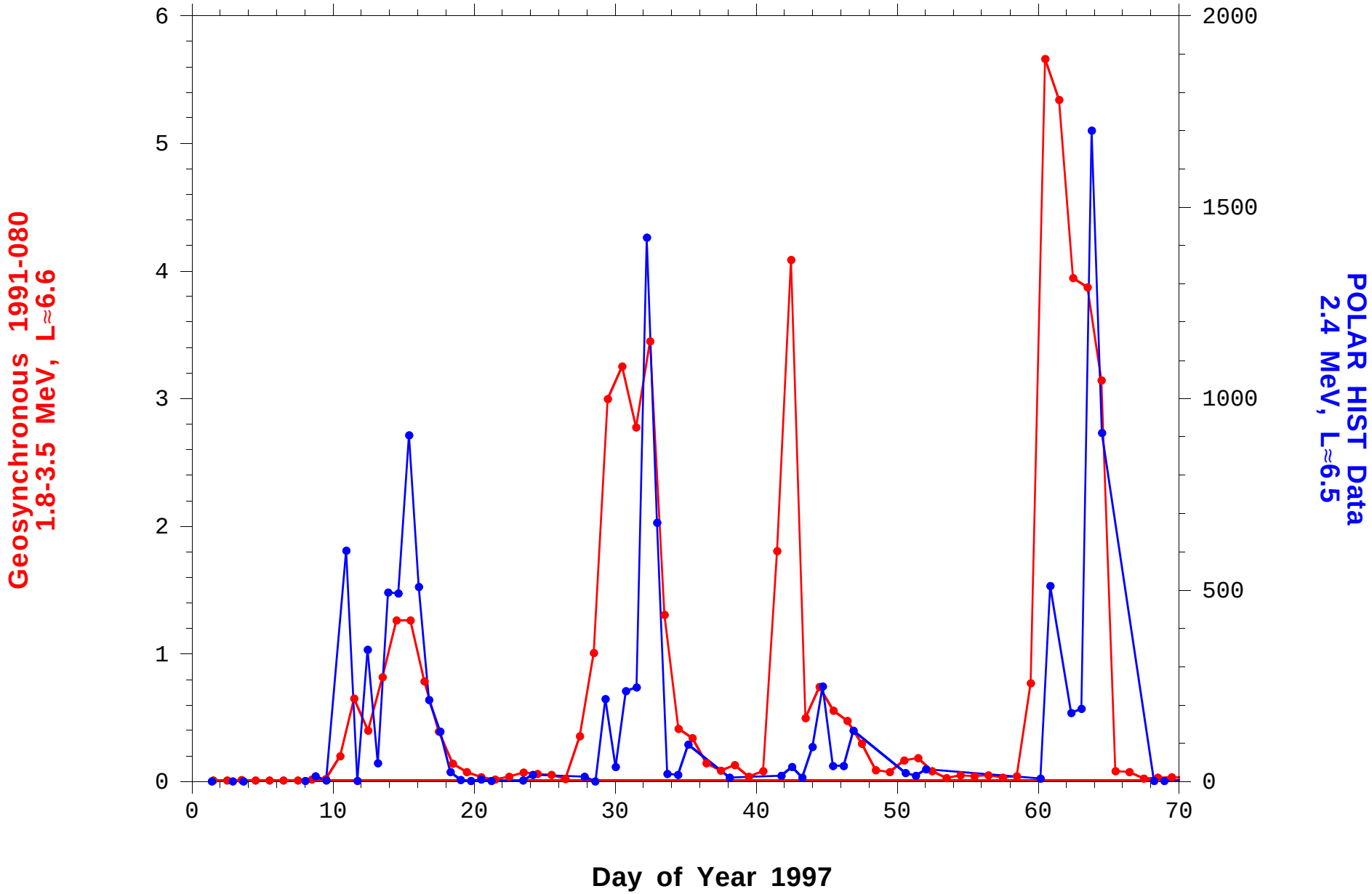
POLAR @ L≈6.5
Geosynchronous @ L≈6.6



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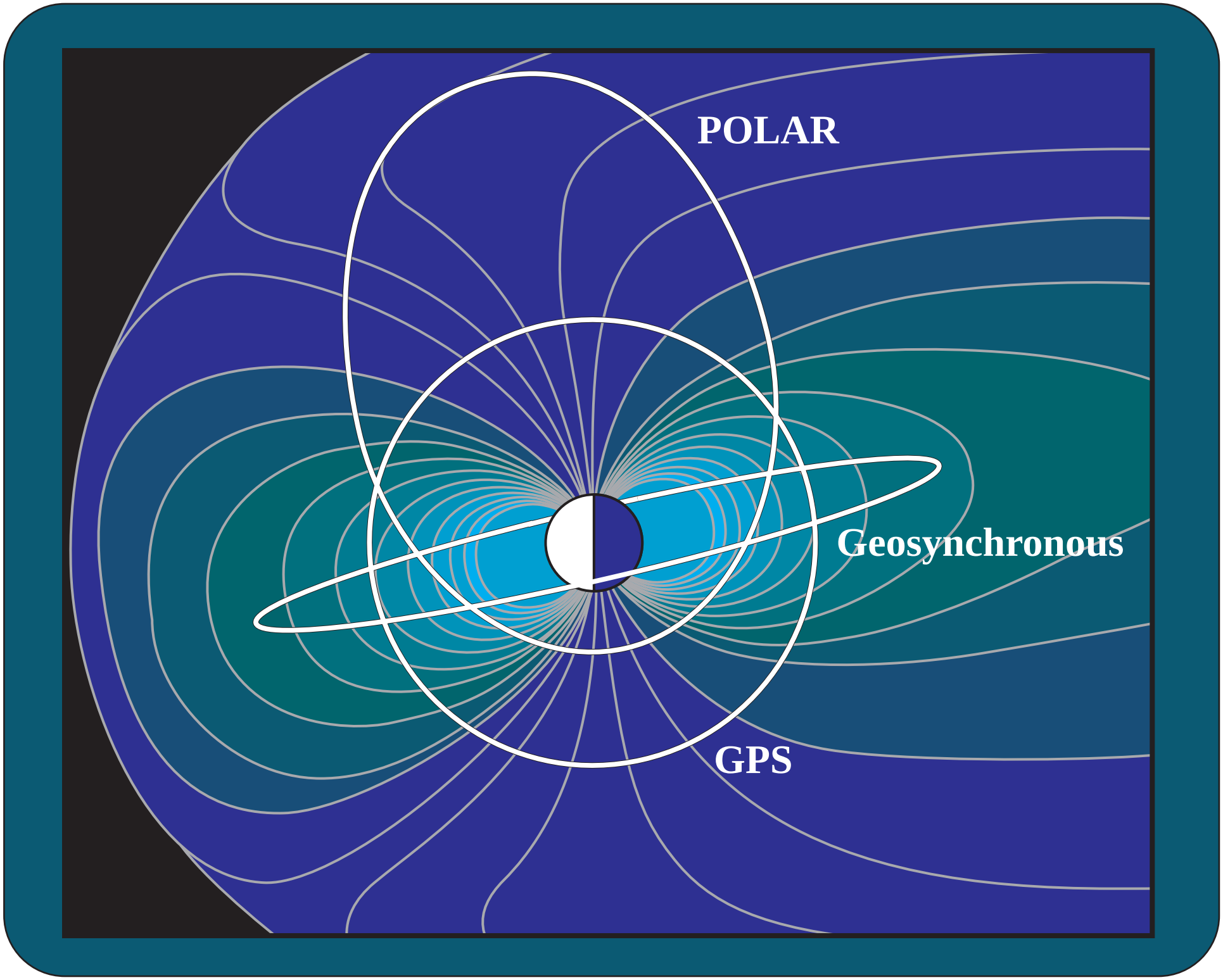

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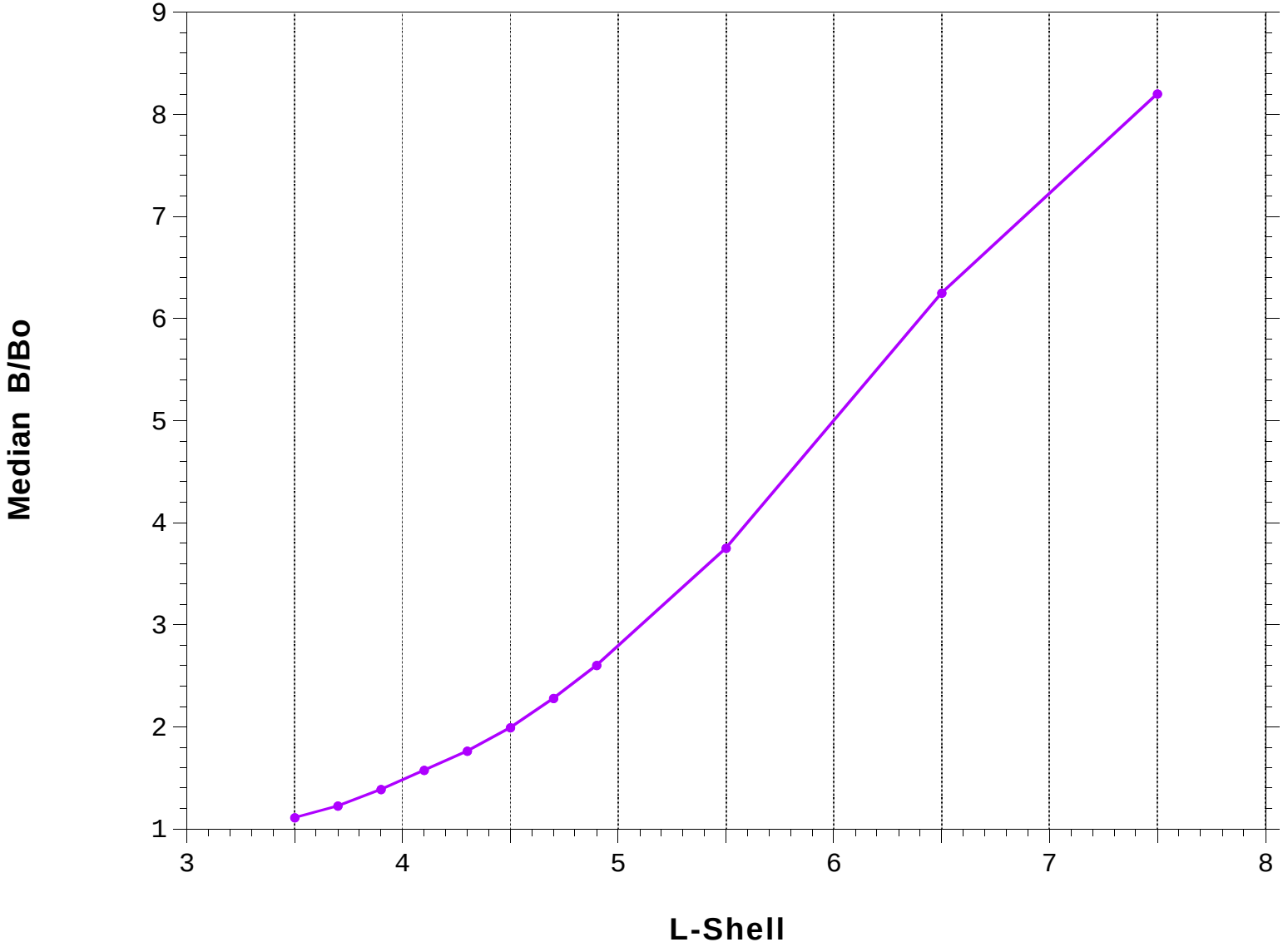
POLAR Location on Field Line



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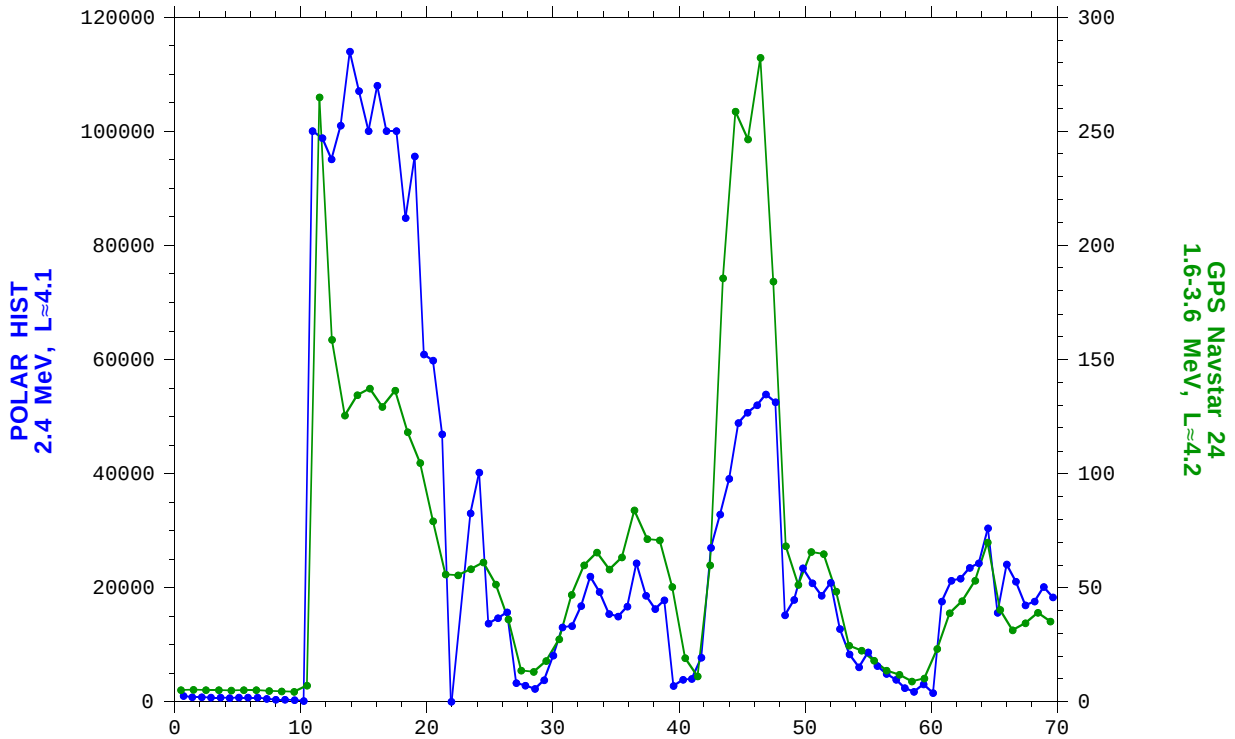
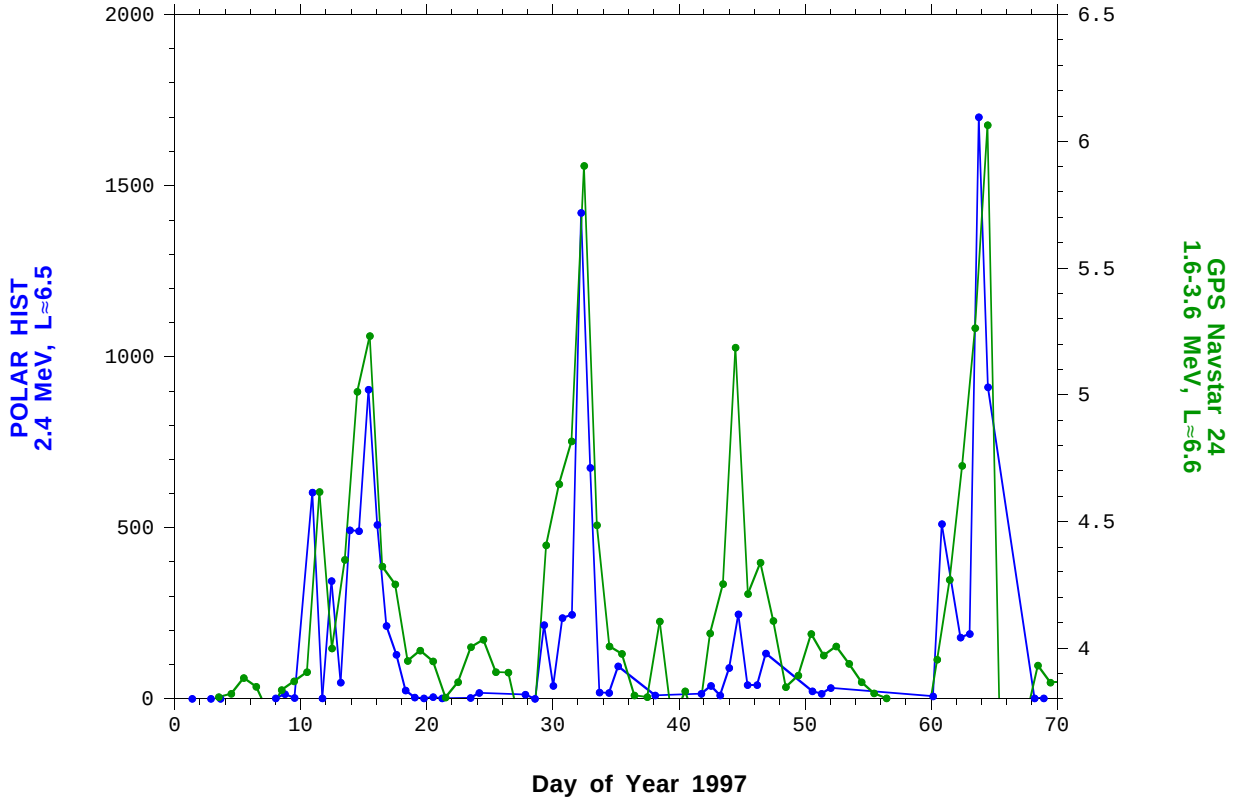
POLAR @ L≈4.1
GPS NS24 @ L≈4.2



POLAR @ L≈6.5
GPS NS24 @ L≈6.6



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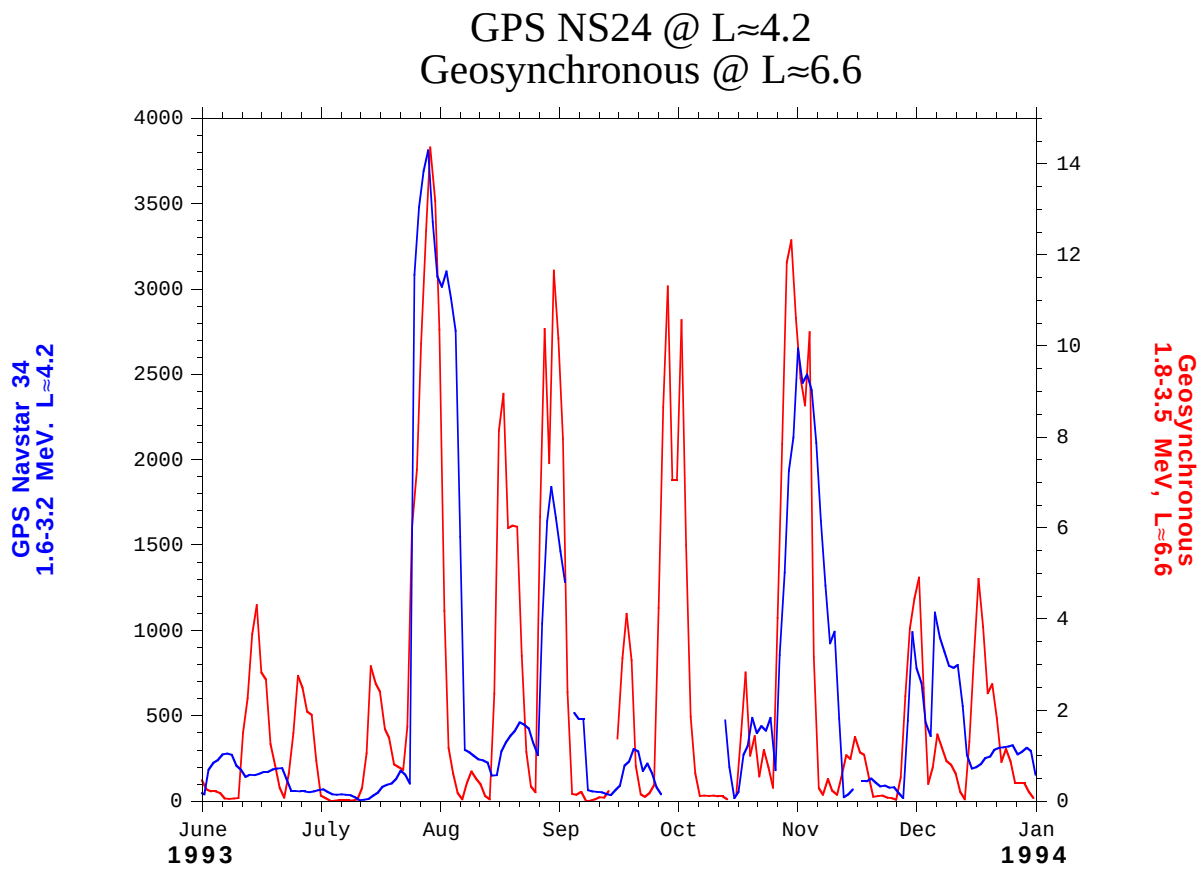
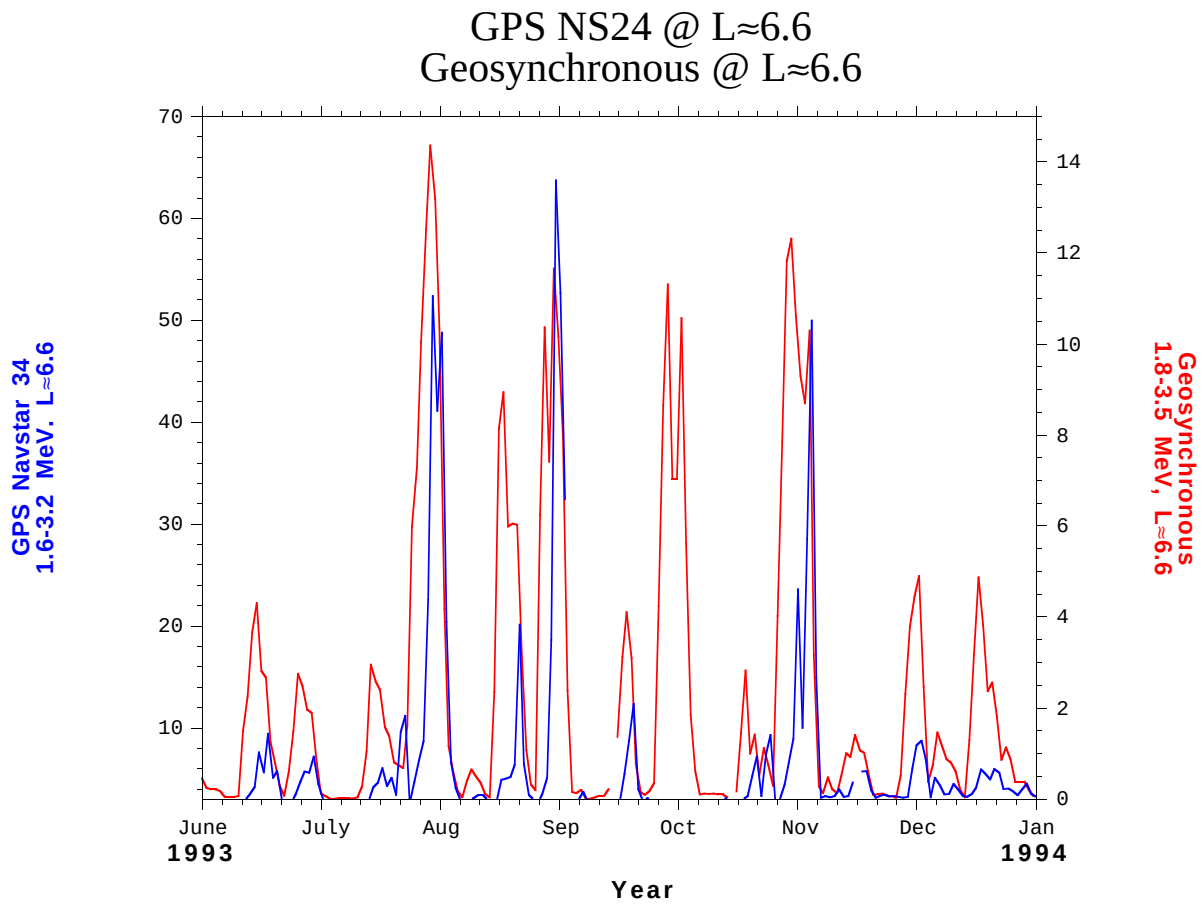
	Delta T (days)	L=4.2	L=4.6	L=5.0	L=5.4	L=5.8	L=6.2	L=6.6
0	-4	31.2	32.2	22.3	11.2	3.9	0.9	0.5
1	-3	41.0	44.5	36.4	24.9	15.9	11.5	10.3
2	-2	51.8	58.1	52.7	42.0	32.3	26.7	23.8
3	-1	62.7	72.4	71.4	62.2	52.2	45.3	39.8
4	0	67.0	75.1	73.4	63.5	52.4	44.5	38.6
5	1	65.2	70.0	68.2	60.6	51.2	44.9	41.1
6	2	58.6	79.3	58.1	53.7	47.3	44.0	42.5
7	3	51.5	48.0	46.1	43.2	39.3	37.4	36.3
8	4	43.0	35.8	31.2	26.7	23.8	21.6	19.6





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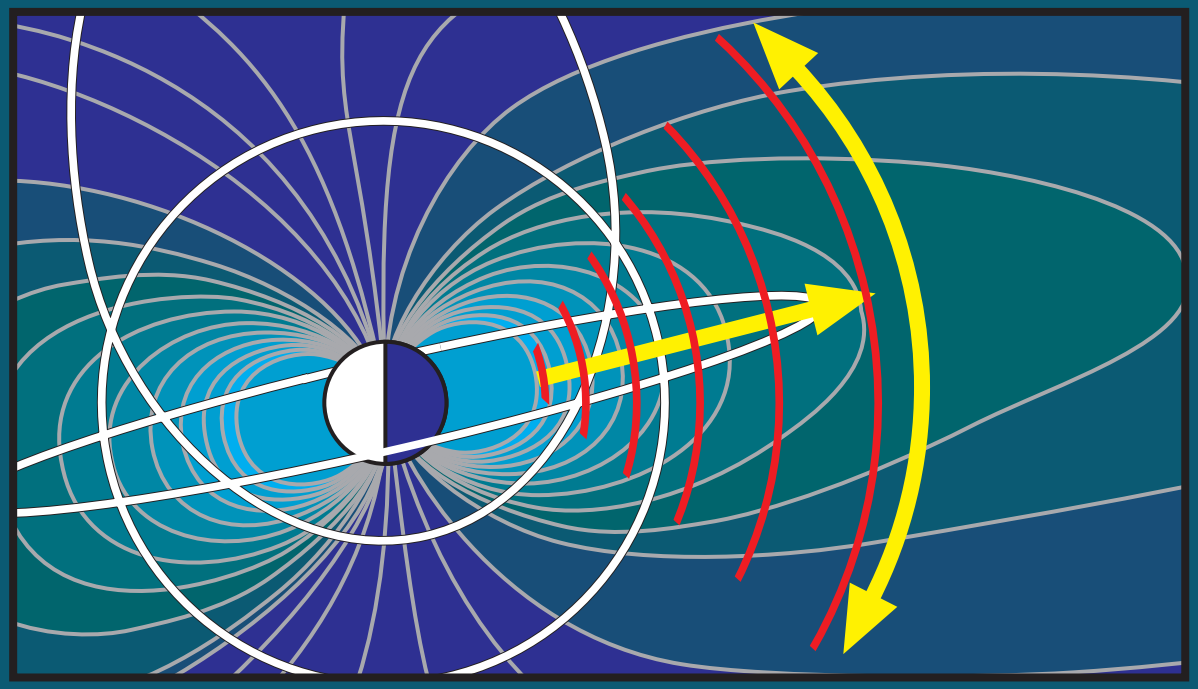
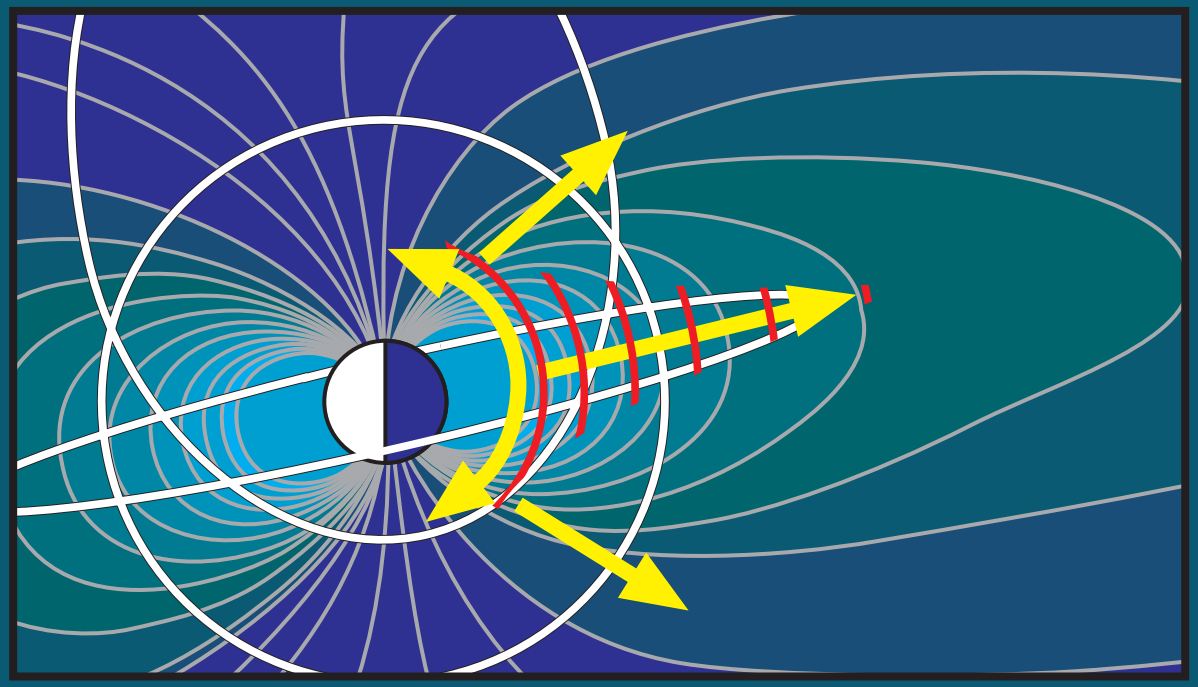


“Out & Up”

Relativistic electron fluxes appear first in the equatorial inner magnetosphere.
They are accelerated at all L-shells or have fast radial diffusion.
They diffuse in pitch angle, slowly, at all L.



“Up & Out”

Equatorial pitch angles still appear first.
Radial diffusion is fast.
But non-equatorial particles are accelerated more slowly or slowly pitch angle diffuse in the source region before diffusing outward.

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Conclusions

- Relativistic electrons appear to be preferentially accelerated at 90° pitch angles !!
- Equatorial fluxes of >2 MeV electrons at $L \approx 4$ and $L \approx 6$ show no systematic time delay
- Equatorial fluxes at $L \approx 3.5$ are delayed by 4-6 days compared to fluxes at $L \approx 4.1$
- At 6.6 R_E, off-equatorial fluxes at $B/Bo \approx 6.5$ are delayed by ≈2 days
- Off-equatorial fluxes have distinctly different temporal profiles than equatorial fluxes and often have a sharp peak near the end of an event
- Delays can be explained by an "Out & Up" or "Up & Out" process. The latter is more likely
- Future Work: Detailed pitch angle studies, Other satellite data sets, Phase space analysis (?)

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