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PLASMASPHERE AND MAGNETOSPHERE STRUCTURE FROM ISEE-1 and DE-1

R. C. Olsen
Physics Department
University of Alabama in Huntsville
Huntsville, AL 35899

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I. INTRODUCTION

The purpose of this grant has been to investigate the density structure of the plasmapause, using the two satellites ISEE-1 and DE-1 to obtain complementary radial and latitudinal profiles. Data from the plasma wave receivers were to be used to obtain the total electron density, and from the ion mass spectrometers to determine thermal plasma morphology. After a substantial delay in initiating the study, good progress is being made in this study.

II. PRESENT RESULTS

Electron density profiles have been obtained for 25 sets of orbits when the satellites were adjacent. Several dozen more DE orbits were analyzed, and either proved unsuitable, or it was found that no ISEE data was available at those times. The first result to arise from these analyses, and subsequent plotting of the data, was the (re)discovery of the L^{-4} density profile exhibited by the plasmapause region (Chappell et al., 1970). This has been emphasized in the way the data were plotted, as shown in Figure lab. Figure la shows an ISEE density profile from day 109 of 1982, plotted vs. L. This is an outbound segment at local dusk (18-21 LT). A sharp plasmapause is found at L = 2.7, 18 LT, 18° magnetic latitude. After that, the decline is slower - in fact L^{-4} is indicated by the solid line, which is normalized to 100 cm^{-3} at L = 4.5. This latter set of values is chosen for convenience in comparing to DE data, and is consistent with recent findings by R. R. Anderson that the 'normal' radius for a 100 cm^{-3} isodensity contour is L = 4.5 (Huntsville Modeling Conference, October 1986). If the data are then normalized by L^{-4}, Figure lb results. The data become a nearly horizontal line, at least from L = 3 to 5, with a slight shift upward from L = 5 to 7. This shift is real (i.e., not a statistical fluctuation) but is probably not significant. A second example of this L^{-4} dependence is illustrated in Figure 2a, from day 243 of 1982. This is a late morning (10-12 LT) segment, outside the plasmapause proper. The third example, shown in Figure 2b, shows two levels of density, each with an L^{-4} dependence. These data, from day 152 of 1982, show inner and outer plasmasphere segments, with a transition at L = 5.8 to 6.0.

This work also allowed for the (re)discovery of detached plasma regions (Chappell, 1974). This is illustrated in Figure 3, again a normalized plot of density vs. L. These data are from day 85 of 1982, 20-22 LT, +15 to -2° magnetic latitude. Plasmaspheric densities (i.e., greater than 100 cm^{-3}) are found inside L = 4.3. There are then lower plateaus, followed by a return to the initial profile from L = 6.05 to 6.50. It can be seen that plotting these 'normalized' densities emphasized the difference between sharp boundaries, and the gradual spatial gradients of the outer plasmasphere.

A major goal of this work was to determine if there are important variations in density with latitude. Using data from low-latitude ISEE orbits, it ought to be possible to remove radial (L) effects from DE orbits at near constant L. This goal has been elusive. During the first example considered for this work, during a local pass on day 126, the latitudinal density profile was determined to be nearly flat (Olsen et al., 1987). The subsequent 2 dozen orbits have either provided ambiguous data, or a similar result, with 1 or 2 possible exceptions. The best case for a latitudinal effect is found in data from day 240 of 1982, in orbit segments just prior to local noon. These data suggest a density minimum at the equator. Figure 4 shows the latitude profile for the DE-1 'normalized' density. The hole at the equator is about a factor of 3, which is significant. The decrease at latitudes less than -20° is associated with higher L-shells, at which the density is decreasing more rapidly. During this period, this density minimum (100 cm^{-3}) is centered at -2.2° latitude, L = 4.24, 2055UT, 12.5 LT. DE approaches the same L-shell as it moves inward, at 2230 UT, 2.18 RE, 44° latitude, 11.65 LT. At that point, the density is close to 200 cm^{-3}. Meanwhile, ISEE-1 gives n = 306 cm^{-3} at L = 4.16 at 17:04 UT, 14.4°, 10.5 LT. Taking into account co-rotation, this means there is still a 2 hour local time separation between DE-1 and ISEE-1, which may cause doubt to fall on the relevance of the ISEE-1 density profile for DE-1.

Our major objective for the remainder of the grant period is to determine the validity of the previous example, and try to obtain 1 or 2 further cases.

III. BUDGET

As of January 8, 1987, we have spent $35,031.72, leaving a balance of $5,487.28. We expect to complete the study within budget.

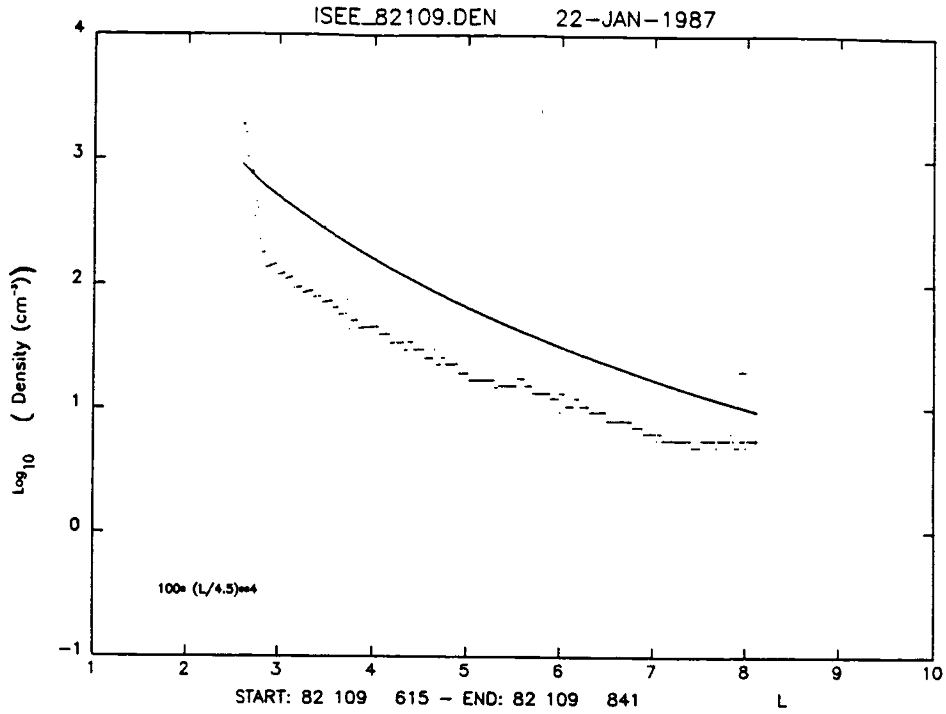
REFERENCES

1. Chappell, C. R., K. K. Harris and G. W. Sharp, The morphology of the bulge region of the plasmasphere, J. Geophys. Res., 75, 1970.

2. Chappell, C. R., Detached plasma regions in the magnetosphere, J. Geophys. Res., 79, 1974.

3. Olsen, R. C., S. D. Shawhan, D. L. Gallagher, J. L. Green and C. R. Chappell, Plasma observations at the earth's magnetic equator, J. Geophys. Res., in press, 1987.

a)


ISEE_82109.DEN 22-JAN-1987
Log10 (Density (cm^-3))
100* (L/4.5)**4
START: 82 109 615 - END: 82 109 841
L

b)

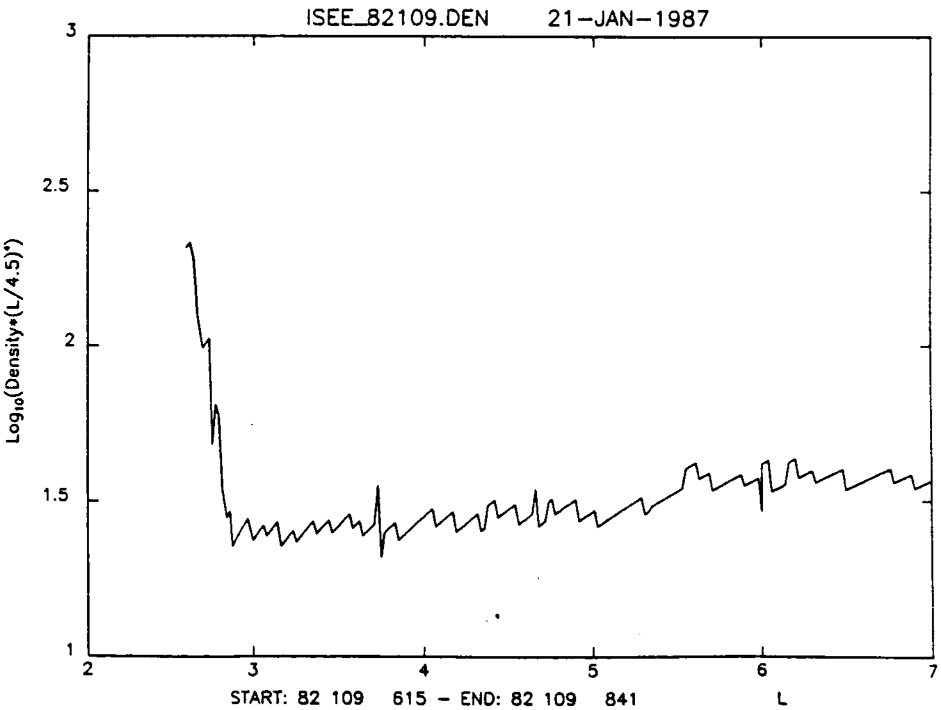
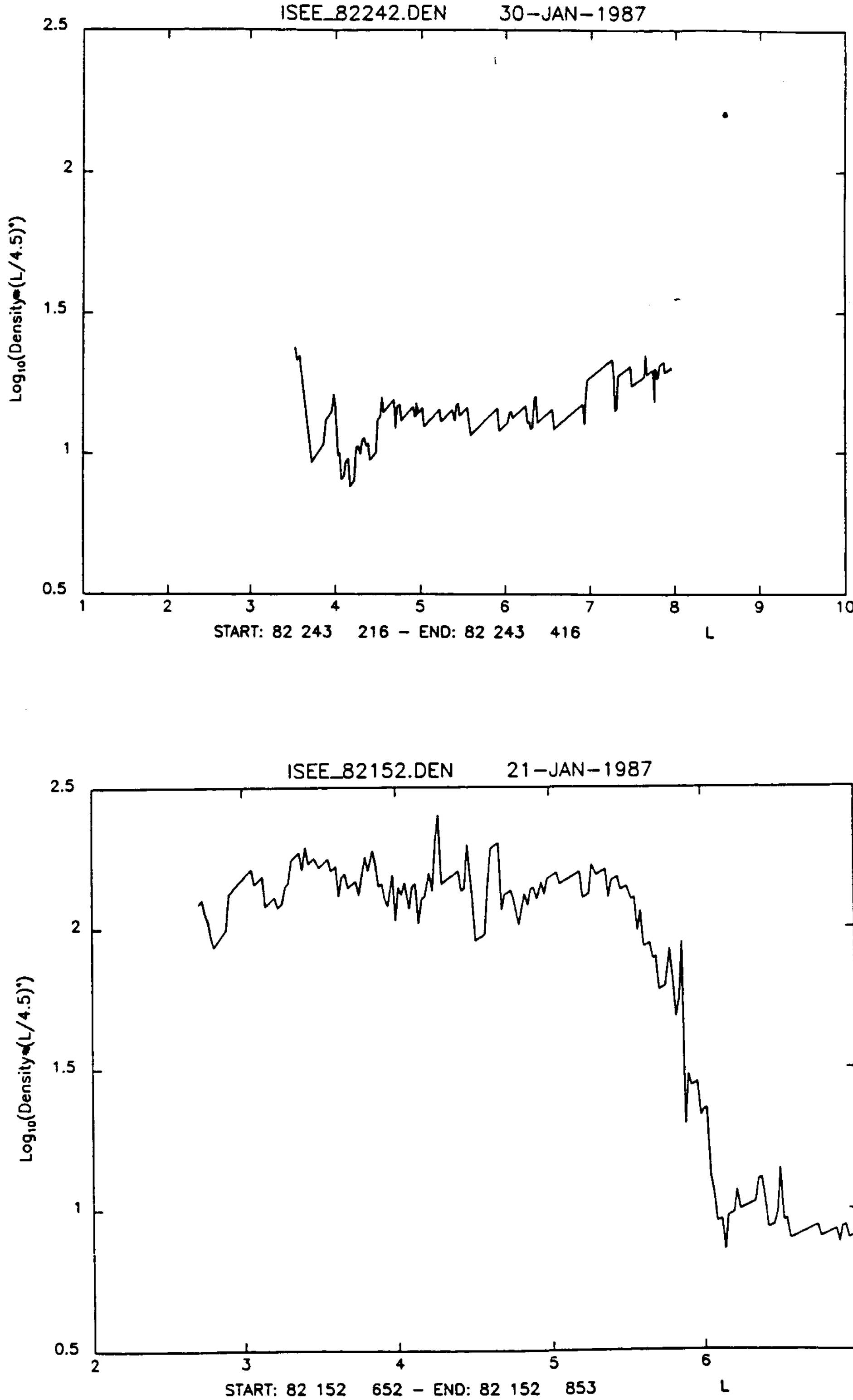

ISEE_82109.DEN 21-JAN-1987
Log10(Density*(L/4.5)^4)
START: 82 109 615 - END: 82 109 841
L

Figure 1

a)

b)



ISEE_82242.DEN 30-JAN-1987
Log10(Density*(L/4.5)^4)
START: 82 243 216 - END: 82 243 416
L
ISEE_82152.DEN 21-JAN-1987
Log10(Density*(L/4.5)^4)
START: 82 152 652 - END: 82 152 853
L

Figure 2

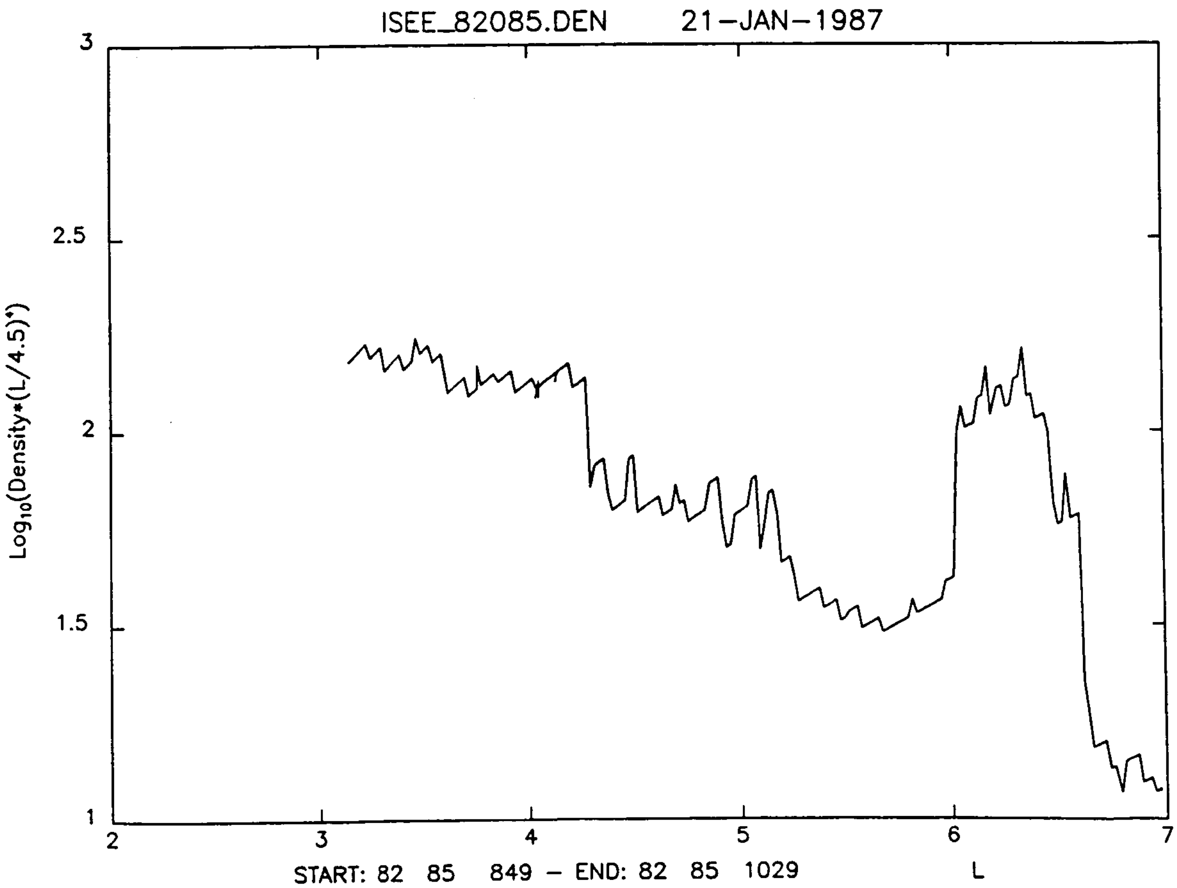

ISEE_82085.DEN 21-JAN-1987
3
2.5
2
1.5
1
$Log_{10}(Density*(L/4.5)^4)$
2
3
4
5
6
7
START: 82 85 849 – END: 82 85 1029
L

Figure 3

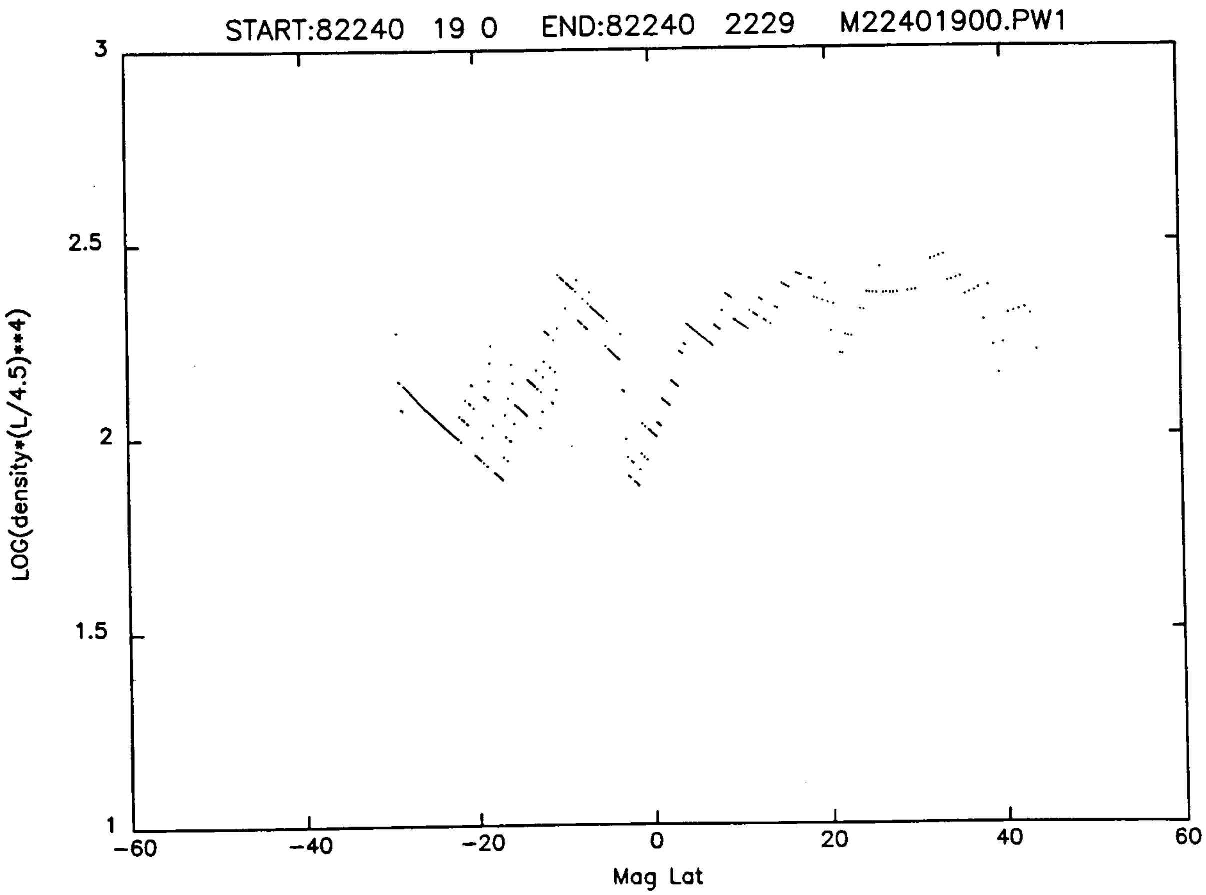

START:82240 19 0 END:82240 2229 M22401900.PW1
LOG(density*(L/4.5)**4)
3
2.5
2
1.5
1
-60
-40
-20
0
20
40
60
Mag Lat

Figure 4