pass to pass was much larger than the uncertainty associated with a single pass. We interpreted a large variance in the L^{*}=2–5, $E<10$ keV He^{+} as indication that the penetrating electron background had affected the "doubles" rate. The arithmetic average is more sensitive to data spikes, but the differences appear to be at most a factor of 2. Neither the H^{+} nor the He^{+} boundary condition at L=7.5 showed much variability, but the He^{++} boundary condition displayed large variance below 10 keV/e. Thus our choice of boundary condition, except for the lowest energy He^{++}, appears unaffected by statistics or variability with an arithmetic average close to the geometric average.

4. Model

The standard model (e.g., SL, SSF) assumes that particles diffuse into the trapping regions from an injection boundary at large radial distances while undergoing various loss processes. Injection probably occurs mainly on the nightside, as particles are accelerated in the tail and convect sunward toward the Earth [*Mauk and Meng*, 1983]. The azimuthal symmetry requirement of the standard model represents this as an injection around a complete circle, which we take at L=7.5, allowing azimuthal drift to smooth out any local time effects. Thus the steady state approximation of the standard model balances inward diffusion from an external source against internal losses to determine the radial profile of the phase space density.

We write the diffusion equation, following SSF as

$$\begin{aligned} 0 &= \frac{\partial f_i(M,L)}{\partial t} \\ &= L^2 \frac{\partial}{\partial L}\left(\frac{D}{L^2}\frac{\partial f_i}{\partial L}\right) - C\frac{\partial f_i}{\partial M} - \Lambda f_i \; [+ S_{ij} f_j] \end{aligned} \quad (3)$$

where f_i is the averaged phase space density for each species i, L is the L shell coordinate; M is the magnetic moment; D is the radial diffusion coefficient; C is the Coulomb drag coefficient; Λ is the charge exchange loss rate; and S is the charge exchange source rate, (not applicable for protons) coupling He^{+} and He^{++} ionic charge states.

Boundary Conditions

We need to specify three boundary conditions. At high M (high $E_{\perp}/B$), we assume f_i=0 since all spectra measured in the magnetosphere eventually decrease with increasing energy. At low L, the atmosphere absorbs all particles, so we set f_i=0 at L=1 for the low-L boundary condition. We do not have to specify a low-M boundary because Coulomb drag can only slow ions down, so that the trajectory of particles in phase space is from high to low energy. Thus the low-M boundary condition has no effect on the solution. Finally we must specify the high-L boundary condition, the "source" region for the model. Ideally, this would be the boundary between trapped and quasi-trapped particles, but since this boundary is "fuzzy," depending as it does on quantities we have averaged over, we use a safer, lower limit of L=7.5 for the outer boundary location. The CCE spacecraft travels out to $L\sim9$, allowing a boundary condition based on experimental data, an average spectrum from L^{*}=7.4–7.6 (Figure 6).

We set the high-M limit of solution space at 50 keV/nT to prevent boundary effects from propagating into the data region, and made a power law extrapolation of the high-L boundary condition, the L=7.5 spectrum, to 50 keV/nT. Since the AMPTE/CCE/HPCE [*Shelley et al.*, 1985] data set does not overlap this quiet time data set, we used low-energy ion spectra for the moderately quiet day 50 of 1985 (S. A. Fuselier, private communication, 1991) to estimate the L=7.5 spectrum down to 10^{-3} keV/nT.

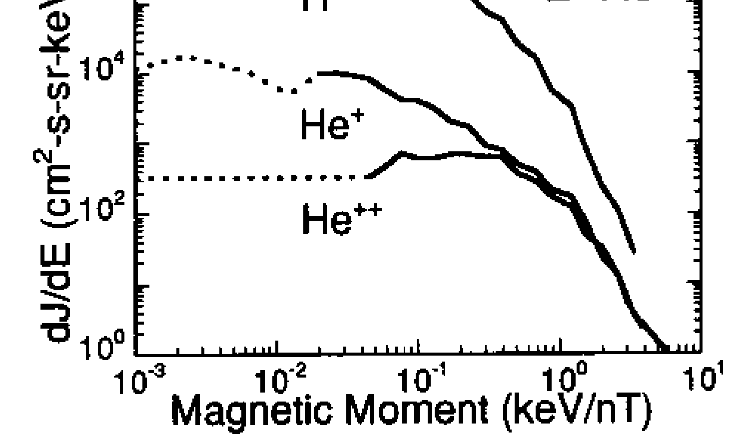

Fig. 6. Boundary conditions at L=7.5 for H^{+}, He^{+}, and He^{++}. Dashed lines are extrapolations from HPCE on day 050 of 1985.

Diffusive Transport

The diffusion mechanism in the standard model is essentially a resonant interaction between the drift period of the ions and magnetospheric magnetic or electric field perturbations. We use *Fälthammer*'s [1965] form for the magnetic diffusion term,

$$D_{LL}^{M} = C_M L^{10+2l} M^{2l} \quad (4)$$

where L is the L shell, M is the magnetic moment in keV/nT, C_M, the amplitude, is about $2\times10^{-15}\ {R_E}^2/s$, and $0<l<2$ is the magnetic spectral power index. The amplitude of the magnetic coefficient depends on the power in the magnetic fluctuations at the drift frequency of the ions. Although there have been measurements of the field fluctuations [e.g., *Lanzerotti and Wolfe*, 1980], the amplitude is not well known. Since a literature survey [*West et al.*, 1981] contains a broad range of calculated and measured diffusion coefficients varying by two to three orders of magnitude, we will consider the amplitude a free parameter in fitting our data.

We use *Cornwall*'s [1971] form for the electric diffusion coefficient that also has two parameters: the strength and duration of the cross-tail electric field fluctuations.

$$D_{LL}^{E} = \frac{C_E L^{10}}{L^4 + ((t/t_0)E_0/Z)^2} \quad (5)$$

where C_E, the amplitude, is about $2\times10^{-10}\ {R_E}^2/s$, E_0 is the energy of the ion in keV at $L\sim7$, Z is the charge of the ion, t_0 is approximately 42 min, and t is the "pulsation time" of the electric field. *Cornwall* [1972] estimates t to be ~1 hour, while *Lyons and Schulz* [1989] estimate a duration of 20 min. This duration determines the energy at which the power law changes from an L^{6} to an L^{10} dependence. Generally the transition is near the top of the CHEM energy range, so the L^{6} form applies to our data. Some measurements of electric fluctuations [*Holzworth and Mozer*, 1979; *Andrews*, 1980; *Earle and Kelley*, 1987] at specific L shells have been made, but it is not clear whether they can be applied to the entire magnetosphere [*Jentsch*, 1984]. Thus we make the amplitude, C_E, an adjustable parameter of the model.

Coulomb Drag

In the ring current, Coulomb collisions with electrons primarily cool the ions without scattering them appreciably. The temperature of the background electrons becomes important in calculating the center-of-mass energy when the ions have energies less than 10 keV. Therefore we do not use the simplest treatment [e.g., *Jackson*, 1975], but rely on a more rigorous derivation of the energy loss due