Ion transport and loss in the Earth's quiet ring current
2. Diffusion and magnetosphere–ionosphere coupling

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Abstract. We have studied the transport and loss of H^+, He^+, and He^{++} ions in the Earth's quiet time ring current (1–300 keV/*e*, 3–7R_E, *Kp*<2+, |*Dst*|<11, 70°–110° pitchangles, all LT) comparing the standard radial diffusion model developed for the higher-energy radiation belt particles with measurements of the lower energy ring current ions in a previous paper (Sheldon and Hamilton, 1993). Large deviations of that model, which fit only 50% of the data to within a factor of 10, suggested that another transport mechanism is operating in the ring current. Here we derive a modified diffusion coefficient corrected for electric field effects on ring current energy ions that fit nearly 80% of the data to within a factor of 2. Thus we infer that electric field fluctuations from the low-latitude to midlatitude ionosphere (ionospheric dynamo) dominate the ring current transport, rather than high-latitude or solar wind fluctuations. Much of the remaining deviation may arise from convective electric field transport of the E<30 keV particles. Since convection effects cannot be correctly treated with this azimuthally symmetric model, we defer treatment of the lowest-energy ions to a another paper. We give χ^2 contours for the best fit, showing the dependence of the fit upon the internal/external spectral power of the predicted electric and magnetic field fluctuations.

1. Introduction

The Earth's ring current ions, which one can measure in the 1–300 keV energy range, incorporate much of the energy of the stably trapped particles in the magnetosphere, roughly comparable to geotail magnetic energy densities. Although the radiation belts were explored and modeled in the earliest years of spaceflight, the ring current composition and distribution has only recently been fully measured [*Gloeckler and Hamilton*, 1987]. Thus models of the ring current region have most often been extrapolations from models develope-d for the higher-energy radiation belts toward lower energy [e.g., *Nakada and Mead*, 1965; *Cornwall*, 1972; *Spjeldvik*, 1977]. These models have concentrated on the effect of high latitude, solar wind control of the ring current and the dramatic effect on *Dst* exerted by a major storm. The standard model of ring current formation and dynamics [see *Sheldon and Hamilton*, 1993, and references therein] (hereinafter referred to as paper 1), assumes that high altitude, external boundary conditions completely determine the ring current densities and structures. That is, particle injection occurs at the inner edge of the plasma sheet around $L\sim8$, and solar wind driven fluctuations power the diffusion that moves the particles earthward. Recent numerical work [*Riley and Wolf*, 1992; *Chen et al.*, 1992] is more realistic only in that it calculates the diffusion from shielded polar cap electric field fluctuations.

However, as we showed in paper 1, this standard model fails to account fully for the high density ring current profiles at L<4 seen during quiet conditions. After considering several options in paper 1, we concluded that only low-latitude to midlatitude ionospheric electric fields (static and fluctuating) can account for this discrepancy. Thus this study will focus on the effects of electric fields on the ring current transport by examining the radial diffusion model at around the limit of its applicability.

We review the data set and model of paper 1 in section 2. In section 3 we derive a new diffusion coefficient for ring current ions that attempts to include the effect of both magnetospheric and ionospheric electric fields into the formalism of standard quasi-linear resonant diffusion. In section 4 we fit parameterized transport coefficients to the data using a maximum likelihood technique and show that an internal ionospheric source of electric fluctuations appears to give the best fit. In section 5 we compare the fitted estimate with measurements of ionospheric fluctuations and speculate on the origin of such fluctuations.

2. Data and Model

Data Set

The data set used for this study has been extensively documented in paper 1, which we here summarize briefly. We have used the charge-energy-mass (CHEM) instrument [*Gloeckler et al.*, 1985] on the near equatorial AMPTE/CCE

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