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Properties of net ionospheric currents closing field-aligned currents in the auroral region

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Satellite missions offer the opportunity to deduce the net electric current flowing through the orbital loop. Suzuki and Fukushima [1982] were the first to apply Ampère's integral law to the along-track magnetic field component from the Magsat satellite. By utilizing the vector magnetic field measurements from CHAMP during 2001-2005, the characteristics of the net auroral currents calculated in this way are comprehensively investigated. It is found that the net currents deduced from noon-midnight (dawn-dusk) orbits are directed duskward (anti-sunward). The intensities of the net currents increase linearly when the merging electric field (Em) at the magnetopause is growing, exhibiting values of about 2 (1) MA for the net duskward (anti-sunward) currents when Em exceeds 4 mV/m. For the first time the seasonal variations of the different net currents are derived. The net currents deduced from full orbits show only little seasonal dependence due to a compensation of the effects between the hemispheres. Conversely, the net currents deduced separately for the two hemispheres exhibit prominent seasonal dependences. For the net duskward currents the amplitudes are larger by a factor of about 2 in summer than in winter. The related cross-polar cap Pedersen currents are higher in the sunlit hemisphere due to enhanced conductivity. Conversely, the net anti-sunward currents (mainly Hall currents) show an opposite seasonal dependence. The ratio of summer-to-winter intensity amounts to about 0.6. In this case the conductivity gradient from the auroral oval to the polar cap is of importance, which is larger in winter.