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An empirical model of field-aligned currents derived from CHAMP magnetic field data

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CHAMP vector magnetic field measurements collected from ∼50,000 polar passes during 2001-2009 are used to produce an empirical model of field-aligned currents (FACs). The set of control parameters includes geomagnetic latitude, local time, season, geomagnetic activity indices, as well as parameters of the interplanetary magnetic field (IMF) and solar wind (SW) flow. In a first step, and for each crossing of the auroral oval, we estimate FAC profiles from the magnetic field perturbations obtained after subtraction of the POMME model from the CHAMP measurements. Minimum Variance Analysis of the perturbation in the plane perpendicular to the ambient field is carried out in a sliding latitudinal window to determine the orientation of current sheets, and then to estimate the FAC density from the tangential magnetic field component. In a second step, the FAC density profile for each crossing is parameterized by a group of scores derived from Principal Component Analysis. Thirdly, we built the relationship between FAC density and the control parameters. We list all available factors having a potential relationship with FAC density such as local time, day of year, 10.7 cm solar radio flux, and various parameters of geomagnetic activity, IMF and SW. Multiple Regression Analysis is employed for assessing contributions from each factor to select the independent variables. Then, Canonical Correlation Analysis is used to investigate the linear relationship between the two sets of variables, the scores and the factors. Finally, the empirical model is constructed on the basis of the canonical function. Our initial results indicate the merging electric field to be the dominant factor determining the FAC density profiles.