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Modeling global magnetic fields in the daily variation band for mantle induction studies

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Accurate models of the spatial structure of source magnetic fields in the daily variation (DV) band (roughly 10^4-10^5 s), will enable 3D exploration of upper mantle conductivity variations, punching through the conductive asthenosphere that typically limits penetration of long period (< 10^4 s) MT data. This would, for example, allow new constraints on transition zone hydration, and possible detection of deep melt layers which have been hypothesized at layer boundaries. Here we present an initial global source model for the DV band for both active and quiet conditions, with both time and frequency domain representations. The initial version of the model is based on frequency domain principal components analysis (FDPCA) of a large collection of modern and historical observatory data. As we develop this further we will include additional ground sites (e.g., magnetometers deployed for space physics studies), and ultimately satellite magnetic data. In this presentation we summarize our approach and present initial results. Using FDPCA global scale magnetic (?) signals are represented by a relatively small number of data modes; (10 explain roughly 90% of variance, more at mid-latitudes). These modes are then fitted using ionospheric current basis functions (20-30/band can fit up to 95% of variance) derived from a similar FDPCA of magnetic field outputs from the Thermosphere-Ionosphere Electrodynamics General Circulation Model (TIEGCM), a mature physics-based numerical ionospheric modeling code. Initially we allow for induced fields with a 1D+thin sheet Earth model, and fit only horizontal components; this step will be refined in the future, using fully 3D Earth conductivity models as these become available. Our approach to Fourier analysis straddles time and frequency domains, allowing the model derived from fitting modes in a series of frequency bands to be transformed to the time domain. The resulting model of ionospheric DV fields is global, and continuous in time (at present for 1995-2015). Combined with 3D current modes derived from TIEGCM, this feature will allow incorporation of satellite data (CHAMP, Swarm) in the model. We discuss our progress on this important extension.