

Using Realistic Regional Geomagnetic Variation Models for Induction Studies

G. Egbert, A. Kelbert, (H. Zhang)

Working with an interdisciplinary team, we have been developing realistic regional models for geomagnetic storm variations over North America. Our modeling approach, which combines ground-based (and ultimately satellite) data with outputs from a physics-based ionospheric model, is discussed in a separate presentation (“Modeling Geomagnetic Storms for GIC Studies”). Here we extend these models to cover all geomagnetic conditions (not just active) and explore uses of these models for induction applications. For example, induction is considered when constructing the source model from ground magnetic data, but usually with only a highly simplified (e.g., one-dimensional) Earth model. Indeed, we seldom have detailed information about Earth conductivity in the full area of interest. We show that once we have a reasonably accurate source model, simple empirical corrections for three-dimensional (3D) effects can be derived from transfer functions (TFs) relating the source model to ground data. These TFs can include locally uniform and gradient components of the source fields, thus providing information about both “anomalous” and “normal” induced fields. The TFs can then be used to improve source estimates by providing more complete correction for induced internal fields and provide information about the 3D induced magnetic fields, which could in principle be inverted for Earth conductivity. As an initial illustration of this idea, we consider estimation of induced fields in high-latitude (auroral and sub-auroral) North America (Alaska and Canada) and explore how these results can be used to improve high-latitude source models for GIC studies in this area. We also will present preliminary results from applying this scheme to data from at least part of the USMTArray, the recently completed magnetotelluric survey of the contiguous U.S., in a lower latitude region where source fields are generally much simpler. One goal here is to obtain reliable horizontal spatial gradient TFs for the full USMTArray data set. The source models should also be useful for studying possible source effects in magnetotelluric impedances and vertical field TFs in USMTArray, and we will present a preliminary evaluation of this possibility.