Measurements of the Earth’s magnetic field collected by low-Earth-orbit satellites such as Swarm and CHAMP, as well as at ground observatories, are dominated by sources in the Earth’s interior. However these measurements also contain significant contributions from more rapidly-varying current systems in the ionosphere and magnetosphere. In order to fully exploit magnetic data to probe the physical properties and dynamics of the Earth’s interior, field models with suitable treatments of external sources, and their associated induced signals, are essential. Here we review the methods presently used to construct models of the internal field, focusing on techniques to handle magnetospheric and ionospheric signals. Shortcomings of these techniques often limit the quality, as well as spatial and temporal resolution, of internal field models. We document difficulties in using track-by-track analysis to characterize magnetospheric field fluctuations, differences in internal field models that result from alternative treatments of the quiet-time ionospheric field, and challenges associated with rapidly changing, but spatially correlated, magnetic signatures of polar cap current systems. Possible strategies for improving internal field models are discussed, many of which are described in more detail elsewhere in this volume.