We describe our development of variational data assimilation (DA) methods for the MoSST (Modular Scalable Self-consistent Three-dimensional) geodynamo simulator. In the variational approach model inputs (initial and boundary data, forcing) are adjusted to simultaneously fit dynamical equations and observational data. This approach to DA provides a natural way to use high quality data from recent years to improve magnetic field and core flow estimates for past epochs, allowing dynamically consistent simultaneous estimation of the time evolution of the core magnetic and fluid velocity fields. It also provides a framework for comparing geodynamo model outputs to data, allowing rigorous tests of dynamical hypotheses, e.g., concerning the strength of the toroidal field in the core. As a first step we have developed the tangent linear (TL) of the MoSST geodynamo simulator, and demonstrated that the linearization remains stable and valid for ~500 years (based on magnetic diffusion time scaling). The next steps, presently underway, are to develop the adjoint (ADJT) of the linearization, and then use the TL and ADJT components to implement a modern variational DA scheme (the so-called representer method) within the framework of the previously developed modular Inverse Ocean Modeling (IOM) system. In addition to applications to variational DA, the TL and ADJT codes can be used to study predictability—e.g., we can characterize fastest growing modes, and characterize sensitivity of forecasts to errors in initial state, or other modeling inputs.