PREDICTION OF GEOMAGNETIC SECULAR VARIATION WITH LARGE-ENSEMBLE GEOMAGNETIC DATA ASSIMILATION

**Allocation:** Innovation and Exploration/80 Knh

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**EXECUTIVE SUMMARY**

The geomagnetic field varies in time, mostly owing to the fluid motion in the Earth's outer core. Geomagnetic data assimilation can provide accurate estimates of the core state for fundamental research into such questions as the Earth's interior structure and its evolution. Geomagnetic data can also provide accurate secular variation (SV) forecasts for global geomagnetic models that are used for industrial and navigational applications.

Accurate prediction of SV can be achieved via large-ensemble assimilation of geomagnetic observations and theoretical geodynamo models that investigate the self-sustaining process responsible for maintaining the Earth's magnetic field. However, this requires at least one thousand times more computing resources (in both CPU time and data storage) than those for pure geodynamo simulation, which alone is already computationally challenging. Blue Waters enables this research by reducing the research time from years to weeks and by increasing resolutions for geodynamo simulations with Earthlike parameters.

**RESEARCH CHALLENGE**

The time-varying geomagnetic field is of fundamental importance for basic and applied scientific research: it provides key information about the Earth's evolution over geological time scales; serves as it establishes a quantitative correlation among the forecast accuracy requirements, computational resource needs, and time periods for progress. For example, with the spatial resolution of approximately 256 x 256 x 256, a single geodynamo simulation (i.e., an ensemble member of GEMS) could require a one-month (wall-clock) computation time with 256 processors/cores. Optimal ensemble sizes can greatly reduce the computational expense and research time without compromising research objectives. In addition, simultaneous 256-ensemble runs can make accurate forecasts of five-year geomagnetic SVs in one month that would otherwise require 20 years if the ensemble runs were limited to sequential executions (one member at a time).

**WHY BLUE WATERS**

Blue Waters provides the computing resources needed for the research team's geomagnetic data assimilation research project.

Further, the technical staff provide much-needed knowledge to improve and optimize GEMS.