High speed networking and large-scale simulation in geodynamics

Weijia Kuang (Space Geodesy Branch, NASA GSFC, MD 20771, Weijia.Kuang-1@nasa.gov), Patrick Gary (Earth and Space Data Computing Division, NASA GSFC, MD 20771, USA, James.P.Gary@gsfc.nasa.gov), Michael Seablom (Science Data System Branch, NASA GSFC, MD 20771, USA, Michael.S.Seablom@nasa.gov), Walt Truszkowski (Advanced Architectures and Automating Branch, NASA GSFC, MD 20771, USA, Walt.Truszkowski@nasa.gov), Jide Odubiyi (Dept. Computer Science, Bowie State University, MD, USA, jodubiyi@att.net), Weiyuan Jiang (JCET, UMBC, Maryland, MD 21250, USA, email jiang@bowie.gsfc.nasa.gov), Dong Liu (JCET, UMBC, MD 21250, USA, dliu@bowie.gsfc.nasa.gov)

Large-scale numerical simulation has been one of the most important approaches for understanding global geodynamical processes. In this approach, peta-scale floating point operations (pflops) are often required to carry out a single physically-meaningful numerical experiment. For example, to model convective flow in the Earth's core and generation of the geomagnetic field (geodynamo), simulation for one magnetic free-decay time (approximately 15000 years) with a modest resolution of 150 in three spatial dimensions would require approximately 0.2 pflops. If such a numerical model is used to predict geomagnetic secular variation over decades and longer, with e.g. an ensemble Kalman filter assimilation approach, approximately 30 (and perhaps more) independent simulations of similar scales would be needed for one data assimilation analysis. Obviously, such a simulation would require an enormous computing resource that exceeds the capacity of a single facility currently available at our disposal. One solution is to utilize a very fast network (e.g. 10Gb optical networks) and available middleware (e.g. Globus Toolkit) to allocate available but often heterogeneous resources for such large-scale computing efforts. At NASA GSFC, we are experimenting with such an approach by networking several clusters for geomagnetic data assimilation research. We shall present our initial testing results in the meeting.