Application Domain:
Earth System Science (weather, climate, natural hazards prediction)

Problem: (What is the technical problem being addressed?)
The NASA Earth Science Enterprise plays a primary role in supporting the Agency's goal "Understand the Earth's system and apply Earth-system science to improve the prediction of weather, climate, and natural hazards." The ultimate challenge of Earth system science is to consolidate the scientific findings in the different disciplines into an integrated representation of the coupled atmosphere, ocean, ice, land, chemistry composition and biosphere. The hallmark of ESE modeling program is the integration of observations with model representations in order to harness the power of space based observation, complete the real-time understanding of the Earth system, and use the observation to improve the prediction in support of policy and management decision making processes.

Benefit: (Why is this problem important? What is the payoff?)
The capacity for advanced computational modeling and simulation is an essential building block for understanding and protecting our home planet. Computational modeling and simulation are what turn data into information. Earth system science, aerospace engineering research, and some aspects of space science are computationally intensive – NASA's research goals cannot be achieved without advanced computing capabilities. Climate modeling in particular is pushing the state of the art in high-end computing to the next level, and other areas of Earth science and aeronautics engineering are not far behind.

Algorithmic technique(s): (What are the main computational methods used?)
High-end computing is used to solve a set of partial differential equations. The discrete form of the equation set is numerically advanced in time to generate the prediction.

Is there a "tipping point" I.e., is the application area not feasible now but that will take off once some measure of computer performance reaches x?

HEC driver/requirement:
 - Why is _high end_ computing needed for progress?
High-end computing capability is absolutely necessary in order for Earth Science modelers to assimilate high-resolution data acquired from space platforms. It is also necessary for more accurate weather forecasting and climate change assessments.
 - What are the high performance computational capabilities or capacities required to enable this application?
Recent requirement workshop has shown Earth System modeling can easily consume 1000x the current capacity for the President's Climate Change Research Initiative.
 - Is your agency likely to be able to provide computers to satisfy this

requirement? If not, why not? (e.g. computers with that can do x will not exist; or we do not have the budget to buy such a machine, etc.

No, we do not have the budget to buy enough computing resource to advance the state of the science. The current investment will only allow small incremental steps of advancement. The current budget environment discourages investment in infrastructure, which is viewed as where the high-end computing belongs. We need to change this perception and make high-end computing a necessary "instrument" for science advancement.