Abstract: Multiscale Climate and Earth System Modeling, Y7

In response to the emerging research needs identified by National Research Council and Intergovernmental Panel on Climate Change, with funding support from NSF and computer support from national supercomputer systems such as Stampede from TACC, we have developed an Integrated Technology-Driven Earth System Model (ITDEaSM) to link technology options, energy use, and policy choices and resultant emissions with Earth system processes that govern climate change, air quality, water quality, and ecosystem. ITDEaSM was developed by coupling and adding capability to a suite of community models to address grand challenges in decadal regional climate predictions and fill in major gaps in existing climate, Earth system, and ecosystem modeling. Multi-decadal simulations are performed using ITDEaSM to estimate the long-term impacts of global climate changes on the global-through-urban earth system, including air quality, water quality/supply, forest, and ecosystem. Our ultimate goal is to quantify such impacts, reduce associated uncertainties, and identify technology choices for co-benefits of climate/Earth system mitigation. With the previous XSEDE allocations, we have published 37 journal papers and a number of additional papers in preparation. During this allocation time period, our work will focus on remaining final production application and evaluation under the NSF project and wrap them up with journal publications. In addition, in an ongoing 5-year project sponsored by the U.S. EPA as part of the EPA's Air, Climate, and Energy (ACE) program, we have further expanded ITDEaSM by incorporating additional regional models such as WRF/Chem-ROMS, WRF-CAM5, and WRF-CMAQ and then apply the global Earth system model (CESM) and four regional online-coupled climate and air quality models to simulate future air quality and climate under various energy transition and global chance scenarios during 2008-2052. We have made critical improvements on those online-coupled models and will continue our application and evaluation at 36-km over North America and nested 12-km over continental U.S. (CONUS) during 2008-2052.
The above simulations will be conducted by 1 research faculty, 2 postdocs, and several graduate students and visiting scholars in our project team. A complex Earth system model like ITDEaSM requires significant high performance computing resources. To achieve our goals, we request 291,234 node hours (SUs) for computation on Stampede 2 and 500 TBs on Ranch or Jetstream to store our model input and output files that will be on the order of 1,502 TBs. During 2018-2019, one postdoc and one research associate left for their jobs, so we were short of manpower to complete our simulations. We have received excellent help from ECSS consultant (Dr. Shiquan Su) since July 2018. During the next allocation period, we would need help from the ECSS collaborators to get all of the code components compiled and running on Stampede 2, which would help our transition from Stampede to Stampede 2. We also need their help to improve the models' efficiency.