Computing and Climate

6 Guest Editors’ Introduction
Computing and Climate
James H. Faghmous, Vipin Kumar, and Shashi Shekhar

9 Climate Computing: The State of Play
V. Balaji
Climate models represent a large variety of both processes on different time and space scales and natural stochastic variability, with computation- and data-intensive simulations needed to extract signals of climate change. Scientific trends are driving toward higher resolution, greater complexity, and larger ensembles.

14 A Guide to Earth Science Data: Summary and Research Challenges
Anuj Karpatne and Stefan Liess
Recent growth in the scale and variety of Earth science data has provided unprecedented opportunities to big data analytics research for understanding the Earth’s physical processes. But Earth science datasets exhibit some unique characteristics (such as adherence to physical properties and spatiotemporal constraints) that present challenges to traditional data-centric approaches.

19 Scalable Multivariate Time-Series Models for Climate Informatics
Yan Liu
Climate data not only have a massive scale but are also of high dimension and complex dependency structures, making the analysis task extremely challenging. Recent advances in machine learning can help researchers tackle a series of problems in climate data analysis, such as climate change attribution, spatiotemporal analysis, and extreme value time-series analysis.

27 Identifying Physical Interactions from Climate Data: Challenges and Opportunities
Imme Ebert-Uphoff and Yi Deng
Recent research has shown the potential of using probabilistic graphical models to identify and visualize interactions in the Earth’s climate system. Studying the resulting pathways is of great interest to scientists because it helps them learn subtle details about the underlying dynamical mechanisms governing our planet’s climate.

35 A Multitask Learning View on the Earth System Model Ensemble
André Ricardo Gonçalves, Fernando J. Von Zuben, and Arindam Banerjee
Earth system models (ESMs) are the primary mechanisms for obtaining projections under different climate change scenarios. Researchers use ensembles of climate models to gain better accuracy and reduce uncertainty. A multitask learning-based method can build ESM ensembles for all regions jointly to improve predictions for individual ones.

43 Can Topic Modeling Shed Light on Climate Extremes?
Cheng Tang and Claire Monteleoni
Understanding changes in climate extremes is an urgent challenge. Topic modeling techniques from natural language processing can help scientists learn climate patterns from data. Recent work extracts global climate patterns from multivariate climate data, modeling relations between variables via latent topics and discovering the probability of each climate topic appearing at different geographical locations.

For more information on these and other computing topics, please visit the IEEE Computer Society Digital Library at www.computer.org/csdl.
Resilience to nonstationarity and deep uncertainty is a prerequisite for decadal to century scale water security. Adaptation is urgent at near-term decadal horizons, when projections of stressors and vulnerability are typically more reliable but climate internal variability may preclude actionable insights. A case study of at-risk power production suggests that informed decisions are still possible.

DISTRIBUTED SYSTEMS

61 The Evolution of Global Scale Filesystems for Scientific Software Distribution

Jakob Blomer, Predrag Buncic, René Meusel, Gerardo Ganis, Igor Sfiligoi, and Douglas Thain

Delivering complex software across a worldwide distributed system is a major challenge in high-throughput scientific computing. To address this problem in high-energy physics, a global scale filesystem delivers software to hundreds of thousands of machines around the world.

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