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Knowledge Discovery from Climate Data using Graph-Based Methods

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Climate and Earth sciences have recently experienced a rapid transformation from a historically data-poor to a data-rich environment, thus bringing them into the realm of the Fourth Paradigm of scientific discovery – a term coined by the late Jim Gray (Hey et al. 2009), the other three being theory, experimentation and computer simulation. In particular, climate-related observations from remote sensors on satellites and weather radars, in situ sensors and sensor networks, as well as outputs of climate or Earth system models from large-scale simulations, provide terabytes of spatio-temporal data. These massive and information-rich datasets offer a significant opportunity for advancing climate science and our understanding of the global climate system, yet current analysis techniques are not able to fully realize their potential benefits.

We describe a class of computational approaches, specifically from the data mining and machine learning domains, which may be novel to the climate science domain and can assist in the analysis process. Computer scientists have developed spatial and spatio-temporal analysis techniques for a number of years now, and many of them may be applicable and/or adaptable to problems in climate science. We describe a large-scale, NSF-funded project aimed at addressing climate science question using computational analysis methods; team members include computer scientists, statisticians, and climate scientists from various backgrounds. One of the major thrusts is in the development of graph-based methods, and several illustrative examples of recent work in this area will be presented.