High-Dimensional Manifold Geostatistics

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Abstract

An understanding of the Earth's climate system benefits all sectors of the economy and environment. Several challenges faced when modeling the Earth's climate system include: estimating geographical features of global datasets, making inferences from multiple data-products, and providing diagnostic tools for complex Earth models. Existing geostatistical approaches address these challenges by modeling points on a high-dimensional space. However, we know that many of the climate datasets additionally have inherent high-dimensional geometric structures.

In this talk, I will provide new insights into problems in climate data science by exploring high-dimensional geometric structures on a manifold. First, I will discuss an approach to improve future projections of a climate variable (e.g., sea-level changes around North America) by learning the scale of correlation, an essential regional feature of climate datasets. Second, I will provide a new framework for data-fusion from multiple sources of information for a given climate variable. Third, I will describe diagnostic tools we created to compare and emulate various Earth system models from numerous international teams and for differing future climate scenarios (e.g., precipitation changes in 2090). With these contributions, I will demonstrate that we can improve the inferences made from geostatistical models by including information about the high-dimensional structures of climate datasets. The proposed novel framework will benefit not only the climate community but also decision makers when identifying plans to mitigate the impact of climate change.

Defense Committee: Dimitris Metaxas (Chair), Vladimir Pavlovic, Kostas Bekris, Jonathan Stroud (Georgetown University), Douglas Nychka (National Center for Atmospheric Research)