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Scientific Knowledge Discovery in Complex Semantic Networks of Geophysical Systems

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The vast majority of explorations of the Earth's systems are limited in their ability to effectively explore the most important (often most difficult) problems because they are forced to interconnect at the data-element, or syntactic, level rather than at a higher scientific, or semantic, level. Recent successes in the application of complex network theory and algorithms to climate data, raise expectations that more general graph-based approaches offer the opportunity for new discoveries. In the past $\sim$ 5 years in the natural sciences there has substantial progress in providing both specialists and non-specialists the ability to describe in machine readable form, geophysical quantities and relations among them in meaningful and natural ways, effectively breaking the prior syntax barrier. The corresponding open-world semantics and reasoning provide higher-level interconnections. That is, semantics provided around the data structures, using semantically-equipped tools, and semantically aware interfaces between science application components allowing for discovery at the knowledge level. More recently, formal semantic approaches to continuous and aggregate physical processes are beginning to show promise and are soon likely to be ready to apply to geoscientific systems.

To illustrate these opportunities, this presentation presents two application examples featuring domain vocabulary (ontology) and property relations (named and typed edges in the graphs). First, a climate knowledge discovery pilot encoding and exploration of CMIP5 catalog information with the eventual goal to encode and explore CMIP5 data. Second, a multi-stakeholder knowledge network for integrated assessments in marine ecosystems, where the data is highly inter-disciplinary.