Coupled Weather-Wildfire Modeling Driven by Sensor and Image Data

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We will review the ongoing NSF funded project on building a dynamic data driven application system for wildfire modeling and prediction. This project includes faculty, postdocs, and graduate students from 5 institutions. The project involves the input of real-time weather, sensor, and airborne imaging data input to modify the state of a simulation, running faster than real time. Modifying the state of simulation to fit the data is called data assimilation.

Because a large fire makes its own weather, the simulation couples a weather prediction code and a wildfire modeling code. The fire model receives the atmospheric state variables (temperature, pressure, wind velocity, humidity) and feeds back to the atmosphere the heat and vapor fluxes.

The simulation code is encapsulated as a black box and an ensemble of simulations is used to represent the probability distribution of the system. Because of strong nonlinearity of the system, standard mathematical techniques do not work. New data assimilation methods are being developed that stabilize the data assimilation and can assimilate data into a highly nonlinear reaction-convection-diffusion process.

The method is being implemented in massively parallel software. The simulations run on separate processors in parallel. The data assimilation process involves linear algebra operations on large dense matrices, which is also done in parallel.