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Using Coupled Fire/Atmosphere Modeling to Advance Wildland Fire Science and Assist Decision Makers

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Advancements in computing and numerical modeling have generated new opportunities for the use of coupled fire/atmosphere models in wildfire research. Models such as FIRETEC attempt to represent the interaction between dominant processes that determine wildfire behavior, including: convective and radiative heat transfer, aerodynamic drag and buoyant response of the atmosphere to heat released by the fire. Such models are not practical for operational faster-than-real-time fire prediction due to their computational and data requirements. However, their process-based model-development approach creates an opportunity to provide additional perspectives concerning aspects of fire behavior that have been observed in the field and in the laboratory; allow for sensitivity analysis that is impractical through observations and pose new hypothesis that can be tested experimentally. Specific examples of the use of FIRETEC in this fashion include: 1) investigation of the 3D fire/atmosphere interaction that dictates multi-scale fireline dynamics; 2) the influence of vegetation heterogeneity and variability in wind fields on predictability of fire spread; 3) the interaction between ecosystem disturbances such as insect attacks and potential fire behavior. Additionally, couple wildfire/atmosphere modeling opens new possibilities for understanding the sometime counterintuitive impacts of fuel management and exploring the implications of various prescribed fire tactics. Results from these studies highlight critical roles coupled fire/atmosphere interaction, which is directly affected by the structure of the vegetation in the vicinity of the fire. Vegetation structure not only impact the amount and distribution of combustible material, but it also influences the winds and turbulence that control the convective heating and cooling of unburned fuels Certainly there need to be continued efforts to validate the results from these numerical investigations, but, even so, they suggest relationships, interactions and phenomenology that should be considered in the context of the interpretation of observations, design of fire behavior experiments, development of new operational models and even risk management.