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Abstract

Importance of interaction between wildfires and surroundings through fluid dynamics

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Abstract:

Wildfires pose a threat to life, property and critical infrastructure, but wildland fire is an unavoidable part of the natural environment. In order to improve our ability to cope with wildfires and anticipate their impacts on the earth system it is important to understand the processes that drive them and the mechanisms through which they are influenced by their surrounding environment. Recent fire behaviour research illustrates the importance of the motion of the atmosphere surrounding a fire and the two-way interactions between fires and the surrounding atmosphere. These motions are influenced by the vegetation structure and nearby topography as well as ambient wind conditions as well as the fire itself. The fluid dynamic response of the atmosphere to a fire and its surroundings influence wildfire behaviour in many ways. The influences of topography on fire behaviour are dominated by terrain-induced changes in entrainment patterns that control the patterns of heat transfer to unburned fuel. Multi-scale two-way fire/atmosphere feedbacks determine heterogenous fireline dynamics and thus fire spread, the effects of fires on ecology and the near-field lofting and transport of the smoke. The fluid motions surrounding a fire influences the effectiveness and consequences of fuels management activities. For example, forest thinning not only removes combustible fuel, but also changes the vegetation drag and thus the ventilation of the fire, which can potentially increase fire spread. The importance of the coupled fire/atmosphere fluid motion surrounding fire is especially important in the context of prescribed fires. Safe use of prescribed fires to reduce fire risk while accomplishing ecologic objectives typically depends on fire practitioner's ability to anticipate the interaction of multiple fires. This interaction is tied to the interaction between the fires through their fire-induced in drafts. It is important to account for the three-dimensional fluid motions surrounding a wildfire in order to anticipate wildfire behaviour. Deciphering the complex interaction between fires and surrounding atmosphere through field and laboratory experiments alone has been challenging due to issues with reproducibility, adequate characterization of natural conditions and complex scaling relationships. Recent advancements in computing power have created new opportunity for the complimentary use of numerical models to provide additional perspectives concerning fire/atmosphere feedbacks that have previously been challenging to explore. A better understanding of the way fluid motions of the local atmosphere influence fire will improve our ability to anticipate fire behaviour and develop effective fire and fuels management strategies.

Keywords: Wildfire behaviour, Fluid dynamics, fire/atmosphere interaction

Biography:

Rodman Linn (Rod) is a senior scientist a in the Earth and Environmental Sciences Division at Los Alamos National Laboratory. Rod has been performing research in the area of wildland fire modeling since 1995. For over two decades, he has served as principal investigator for a process-based coupled fire/atmosphere model, FIRETEC. Rod leads LANL efforts to use next-generation process-based wildfire models for the study of fundamental wildfire behaviour, evaluation of prescribed fire tactics, understanding influences of complex environmental conditions on fire behaviour, risk assessment for critical facilities and wildfire's interaction with other landscape disturbances such as insects or drought. Most recently he has partnered with a group of researchers at LANL, USFS and Tall Timbers to apply what has been learned through physics-based wildfire modelling to the development of a new type of fast-running simulation tool that can be applied to prescribed fire applications.