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DATA ASSIMILATION AND WILDFIRE MODELLING WITH WRF AND SFIRE

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Résumé :

Wildfires burn tens of millions of acres per year and threaten the lives and property of numerous people. The rate and and intensity of these fires has been increasing in recent years. As a result, there has been increasing interest in the development of improved forecasting and prediction of these events. Historically, wildfire models have been nothing more than simple scalar spread rate formulas generated from laboratory experiments. Several new spatial wildfire models have been in development in recent years, but there remain issues related to computational limitations and data availability that restrict the ability of these models to accurately predict the true fire spread. Further difficulties arise in attempts to correct for errors in the initial conditions and the model itself. Due to the highly non-linear nature of wildfire models, traditional atmospheric data assimilation methods break down.

We have developed a new semi-empirical wildfire model (SFIRE) which is coupled with WRF as a physics module. This fire model works by evolving a level set function according to empirical spread rates given known fuel categories, topology, and atmospheric conditions. On return, the fire model adds a heat flux and, optionally, chemical tracers to the lower boundary of the atmosphere. The model itself has been compared favorably with real data from wildfires and controlled burns with faster than real time execution.

While WRF and SFIRE have been shown to provide accurate reanalyses of historical fires, predicting the spread of an on-going fire remains a problem due to the lack of data at the onset of an incident. It is therefore necessary to modify the simulation in response to new data as it is received; however, it can be shown that traditional data assimilation methods fail when applied directly to this model. As a result, the Morphing Ensemble Kalman Filter has been developed. This filter attempts to decouple the errors related to the amplitude of the fields from spatial errors related to the location of features in the fields using the idea of a morphing transformation borrowed from image registration. This method has been applied with some success to other areas of research, from hurricanes to epidemic spread, where location is of principal importance.

With the new fire model, an operational system has been developed in collaboration with Weather-It-Is, Inc. to predict the spread of wildfires in Israel. This product is generated from a 1.3km resolution regional model with custom moisture and fuel datasets. It automatically creates geotagged images representing fire spread, fire risk and local wind conditions, which are viewable in Google Earth. Similar projects are in progress in the United States that incorporate NASA satellite imagery. While these products do not currently incorporate in-line data assimilation techniques such as the Morphing Ensemble Kalman Filter, work to incorporate an operational data assimilation scheme is ongoing.

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