International Congress on Environmental Modelling and Software

8th International Congress on Environmental Modelling and Software - Toulouse, France - July 2016

Jul 13th, 3:30 PM - 3:50 PM

Data-driven wildfire behaviour modelling: application of FIREFLY to field-scale grassland controlled burns

M. C. Rochoux
CECI, CNRS-CERFACS, melanie.rochoux@cerfacs.fr

C. Zhang
University of Maryland at College Park, cong0129@umd.edu

D. Lucor
LIMSI, didier.lucor@limsi.fr

S. Ricci
CECI, CNRS-CERFACS, sophie.ricci@cerfacs.fr

A. Trouve
University of Maryland at College Park, atrouve@umd.edu

International Environmental Modelling and Software Society (iEMSs)
8th International Congress on Environmental Modelling and Software
Toulouse, France, Sabine Sauvage, José-Miguel Sánchez-Pérez, Andrea Rizzoli (Eds.)
http://www.iemss.org/society/index.php/iemss-2016-proceedings

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Data-driven wildfire behaviour modelling: application of FIREFLY to field-scale grassland controlled burns

M.C. Rochoux[(a)], **C. Zhang**[(b)], **D. Lucor**[(c)], **S. Ricci**[(a)] **& A. Trouvé**[(b)]

(a) CECI, CNRS-CERFACS, 42 Av. Gaspard Coriolis, 31057 Toulouse cedex 01, France melanie.rochoux@cerfacs.fr; sophie.ricci@cerfacs.fr

(b) Dept. of Fire Protection Engineering, University of Maryland, College Park, MD 20742, USA, cong0129@umd.edu; atrouve@umd.edu

(c) *LIMSI, Campus universitaire bât 508, Rue John von Neumann, 91405 Orsay, France didier.lucor@limsi.fr*

Abstract: Assessing epistemic uncertainties is now considered as a milestone for improving numerical predictions of a dynamically evolving system. The objective of this project is to demonstrate the benefits of data assimilation combined with sensor observations of the fire front position to both quantify and reduce the uncertainties in wildfire behaviour forecasting capability. The challenges found on the route to modelling wildfire behaviour are two-fold. There is the modelling challenge associated with providing accurate representations of the multi-scale multi-physics processes governing wildfire dynamics. There is also the data challenge associated with providing accurate estimates of the environmental conditions (biomass moisture, near-surface wind) that are provided to the model as input parameters. We discuss the sequential application of the ensemble Kalman filter (EnKF) to wildfire spread models for correcting in a spatially-distributed way, input parameters and the fire front position in order to better track the fire front position. We also investigate the ability of a polynomial chaos surrogate to mimic the wildfire spread model in the EnKF algorithm to evaluate at reduced cost the error statistics between the estimation targets and the model quantities of interest. We demonstrate the benefits of combining uncertainty quantification and data assimilation strategies for improved wildfire spread forecasting on controlled burns, among which the 30-hectare FIREFLUX experiment. As a perspective, the data-driven prototype simulator named FIREFLY (http://firefly.cerfacs.fr/) will be extended to fire hazard events stretching over several hundreds of hectares such as the Maido fires (La Réunion, 2011, acquired via RapidEye within the EU SAFER project).

Keywords*:* Wildfire; Fire modelling; Front propagation; Data Assimilation; Ensemble forecasting.