Nat. Hazards Earth Syst. Sci. Discuss., 2, C1006–C1009, 2014
www.nat-hazards-earth-syst-sci-discuss.net/2/C1006/2014/

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "Towards predictive data-driven simulations of wildfire spread – Part I: Reduced-cost Ensemble Kalman Filter based on a Polynomial Chaos surrogate model for parameter estimation" *by* M. C. Rochoux et al.

G. Pagnini (Referee)

gpagnini@bcamath.org

Received and published: 5 June 2014

In this paper, the authors propose a valuable approach to improve the simulation and prediction of wildland fire propagation by using a data-driven model. A data assimilation algorithm based on an ensemble Kalman filter is developed for estimation of parameters involved in the computation of the Rate Of Spread (ROS). This approach is implemented into a prototypical model where the fire perimeter is described by the level-set method and the ROS by Rothermel's formula. Moreover, a method to reduce

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

computational costs of simulation is also investigated.

In my own opinion the paper is well written. The introduction is so clear and rich of literature that it deserves the publication in itself. The description of the work is fluent and this shows the deep knowledge that authors have of the considered topic. Figures are enough to present the idea and the results.

I have some *general remarks* and *minor remarks*.

<u>*General remarks*</u>

Two types of stochasticity exist in wildland fire propagation, as reported by authors in page 3294 lines 4–7,

"Model uncertainties are a combination of epistemic errors that express an imperfect knowledge of the input parameters of the ROS model (that could in theory be removed), and of aleatoric errors that result from natural and unpredictable stochastic variabilities of the physical system."

Authors address the solution for uncertainties *"of the input parameters of the ROS model"*. In this respect, consistently with pure statistical arguments, errors are assumed to be Gaussian (see e.g. page 3308 lines 7–14, page 3295 lines 22–25, page 3299 lines 17–24, formula (23) and I guess also in formula (26)).

A number of assumptions and simplifications are obviously done to investigate the potentialities of the approach. An introductory sentence concerning the fact that this is a feasibility study could be appreciated by readers as well as a brief description of results obtained and discussed in the second part of the paper to give a more comprehensive presentation of the research. By the way, in order to avoid misunderstandings with readers looking for ready-to-use models, the explanation of some chosen values of parameters can also be given. On my side, I think for example to the values of standard deviations. Since the procedure is fully statistical rather than physical, I have the feeling that at this stage authors choose standard deviations according to a confidence inter-

NHESSD

2, C1006–C1009, 2014

val decided by the user. So, a brief discussion about these choices could be included together with a longer explanation of figure 9 and also of chosen values $x^{\mathrm{t}} = 0.4\,\mathrm{s}^{-1}$ and $x^{\mathrm{f}} = 0.2\,\mathrm{s}^{-1}$. I wonder if there is the possibility of an automatic best selection of some parameters while the code runs.

Without abusing of my referee position, I would like to mention here a recent approach proposed by me an co-authors [1,2] which is quite close to the present one but that is intended to consider the *"aleatoric errors that result from natural and unpredictable stochastic variabilities of the physical system"*. In this respect, statistics are not always Gaussian but are determined according to models of the underlying physical processes and the statistical moments of trajectories of fire markers can be derived as well on the basis of physical arguments. The added computational cost of this approach is that of an integral over the considered domain, even if it is based on the idea of many independent random realizations. The two approaches seem to be consistent in their stochastic formulations and complementary towards the inclusion of both families of randomness sources in wildland fire simulations. Authors could briefly discuss analogies and differences with this approach.

Page 3306, line 5, parameter r is introduced. I think that a better explanation of this parameter should be given.

Minor remarks

1) Symbols ϵ and ε are used for the Gaussian random error, see page 3299 line 23, and for the dimensionless effective heating number, see page 3301 formula (1) and line 15, respectively. However, because of the font style, their difference is very small.

2) Notation in (8), i.e. $[(x_i, y_i)\, 1 \leq i \leq N_{fr}]$, is different from the same type of notation in (9) and (33), i.e. $[(x_1^o, y_1^o)\,(x_2^o, y_2^o)\,\ldots\,(x^o_{N^o_{fr}}, y^o_{N^o_{fr}})]$.

NHESSD

2, C1006–C1009, 2014

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

3) In pages 3392, 3395, 3398, 3305 and 3306, the reference Rochoux et al. (2014) is reported. But, if I well understood from bibliography, this publication is the PhD Thesis of M.C. Rochoux and then it should be cited as Rochoux (2014). Moreover, still from the bibliography, it is reported that such PhD Thesis is written in English. Hence, the title in English may be given for readers' convenience.

4) In reference Burgers et al. (1998), the name Kalman is typed with small initial letter.

5) In reference Xiu & Karniadakis (2002), journal name is written in full without using the abbreviation in contrast with all other journals.

[1] Pagnini G., Massidda L., The randomized level-set method to model turbulence effects in wildland fire propagation, in: Modelling Fire Behaviour and Risk. Proceedings of the International Conference on Fire Behaviour and Risk. ICFBR 2011, Alghero, Italy, 4–6 October 2011, edited by: Spano, D., Bacciu, V., Salis, M., and Sirca, C., 126–131, ISBN 978-88-904409-7-7, 2012.

[2] Pagnini G., Mentrelli A., Modelling wildland fire propagation by tracking random fronts. Nat. Hazards Earth Syst. Sci. Discuss. 1, 6521–6557 (2013).

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 3289, 2014.