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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Forecasting wind-driven wildfires using an inverse modelling approach" *by* O. Rios et al.

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The authors would like to thank the three referees for their valuable comments that helped to improve the paper. The particular reply to each referee and the issues addressed are as follows.

Answer to Referee #1:

We had explicitly addressed already the definition of the term 'invariant' and the meaning of its spatial and temporal variations. This is in the manuscript, starting in line 11 of page 6926: "Invariants are the set of governing parameters that are mutually independent and constant for a significant amount of time. Therefore, our implementation relies on the assumption that some physical attributes of the system remain constant

at least during some time. Those attributes can be uniform, a scalar or a vector field with spatial dependency. Examples of such quantity are initial fuel's moisture content or fuel depth" This explanation is improved in the revised version by adding that from the point of view of our methodology, invariants are a central concept to forecasting systems that do not focus on the initial conditions only. For example, weather forecasting solves an inverse problem to find the initial conditions, and then run the forward model for predictions. In our work, we solve the inverse model of selected key parameters inside the governing equations, the invariants, not the initial conditions. It is an essential property of the invariants that they remain constant during the lead time of the forecast. When any invariant changes significantly (eg. due to divergence of the assumptions or external conditions) its effect is to limit the lead time. The two typos noted have been corrected in the revised version.

Answer to referee #2 Prof. Simeoni:

We have revised the literature review to highlight the novelties of our work as compared to others. The greatest strengths of our method are lightness, speed and flexibility. We specifically tailor the forecast to be efficient and computationally cheap so it can be used in mobile systems for field deployment. Thus, we put emphasis on producing a positive lead time and the means to maximize it, while at the same time solving for multiple invariants. These are not the objectives of other papers in the literature. For example, Rochoux et al. 2013, the truly first paper in the literature that effectively forecast wildfire behaviour, integrates measurement errors with model errors to increase accu racy (standard procedure in weather forecasting), but it comes at the price of higher computational expenses. Rochoux et al. 2013 and Mandel et al. 2008 use one single parameter at a time and do not address lead times. Moreover, they seemed tailored more towards supercomputing platforms than to mobile systems for field deployment. Another highlight of our method is to have implemented Automatic Differentiation into the inverse model, which is accurate and fast, further decreasing the computational expenses of a forecast. The work of Coen and Schroeder (2013) is most interesting and we thank the referee for bringing this to our attention. It has been included in the revised version as part of the literature review. It was not include before because Coen and Schroeder was published after we had submitted to NHESSD. Also after submission, we have learnt that Rochoux and co-authors have published a new version of their work for an incoming conference in 2014 (11IAFSS). This has been included in the literature as well. A fine-tuned discussion on whether data assimilation should involve more complex models or not is rather spurious at this point. This will be decided by the International wildfire community at large, specially the Fire Service. If the development of weather forecasting systems over the last few decades can serve as guidance somehow for wildfire forecasting systems, we note that they currently simulate weather patterns in a series of model of diverse complexity which grids range from fine and regional to global and course. So far, we can show that our wildfire forecast method is light, fast and flexible. It can be adapted to run on models of any complexity, and we show its strengths here using synthetic data and a model that albeit rather simple, it is the most widely used model by the international wildfire community. Future work will look into real data (eg, Coen and Schroeder (2013) data?) and improved and faster models. This discussion has been added in the revised version. The typo noted have been corrected in the revised version

Answer to referee #3:

Invariant is a concepts already in the literature in our previous work on forecasting fire dynamics (see Jahn et al). Therefore, we are keen on maintaining the keyword "invariant". We are following the suggestion of Reviewer #3 and include the sentence "We define the invariants as the set of governing parameters governing parameters that are mutually independent and constant for a significant amount of time". Following the suggestion, we are adding a new section to the paper explaining in detail how the numeric of the model is handled. All figures will be normalized and follow the same formatting.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 6923, 2013.