Nat. Hazards Earth Syst. Sci. Discuss., 2, C244–C252, 2014
www.nat-hazards-earth-syst-sci-discuss.net/2/C244/2014/

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "New features in WRF-SFIRE and the wildfire forecasting and danger system in Israel" *by* J. Mandel et al.

Anonymous Referee #1

Received and published: 26 March 2014

General comments

This paper essentially provides a precis on the recent improvements made to the Weather and Research Forecasting-SFIRE modelling system and provides a brief overview of the application of the system to a fire danger forecasting system in Israel. Overall the paper reads satisfactorily but suffers from an assumption that the reader understands many of the acronyms and terms used in the paper from previous WRF-SFIRE papers. Similarly there are also a large number of statements, particularly in the first half, that need to be supported by appropriate references.

Additionally, many of the new additions to the system do not provide sufficient information for proper peer-review if they haven't already been reviewed. As a result, the

statement 'This paper consolidates for the first time in journal form new developments in the SFIRE software system' worries me greatly if the authors are seeking to validate their work in a peer-review journal in this manner.

Of considerable concern is the fuel moisture model that is 'tested' against an historical fire for which there is little detailed observation of spread and no direct measurements of fuel moisture content. The performance of the fuel moisture model is then inferred from incomplete data. A simple analysis of the data provides indicates that the fuel moisture model lags considerably behind what would be expected of fine fuel moisture contents driving fire behavior and subsequently the fire behavior lags even further behind what would be expected. The fuel moisture model needs to be properly assessed and validated against complete independent data. Once this is done, the fire behavior prediction then needs to be assessed and validated.

The English grammar is proficient but there is frequent occurrence of clumsy or poorly phrased grammar that needs to be revised. Despite the title, there is no mention in the abstract of the Israel fire danger system. One wonders whether the title is overly specific in this case, given that the operational use in Israel is only 40 lines long. Perhaps something along the lines of 'Recent advances and applications of WRF-SFIRE'?

Specific comments:

P1760: L1 Insert 'have' before 'made' L5: 'WRF-SFIRE' needs to be defined. L6: Issue with phrasing here 'fireline intensity' is not a new concept. I think you mean 'a new interpretation of fireline intensity'. L20: The small scale processes involved in wildland fire state well before flames appearâĂŤit occurs at the scale of molecules in the thermal degradation chemistry. See Sullivan and Ball (2012) for an overview of the chemistry involved. Also see the review of wildland fire modelling series by Sullivan (2009a,b,c) for discussion of the complexity of the problem. L21-23: This discussion focuses on the atmospheric component of turbulent processes and ignores the critical ingredient of heat transfer processes to unburnt fuels that drive fire spread.

L23-25: This explanation of the importance of larger scale weather contributions is rather weak and unconvincing. What is the importance of cascading eddies in regard to fire behavior? Change 'lager' to 'larger'.

P1761: L2: Explain here why fuel moisture, driven by atmospheric conditions, is important for what you're doing. L5: The refs here are only two examples of the type: Insert 'e.g.' before 'Linn'. L6: Computation time is just as important in regard to operational applicability, not just costs. L9: 'is practically impossible'. You just said on L5 that it was technically feasible. Which is right and clarify what you mean. L10: Another example of poor phrasing here and throughout: 'allows to' should generally be 'enables' or, in this case, the more active '...model captures a practically. . .' L12: Provide a ref for this first sentence. How do winds drive the fire propagation? L14: In wildland fuels, the key ingredient is in fact carbohydrates, not hydrocarbons. L16: What are 'fire storms' and how are they generated? Provides refs. L18: "'it's own weather" Provide a ref. L22: Define 'simple fire spread model' How simple? How complex? Does it matter? Again poor phrasing with 'allows to'âĂŤchange to 'captures'. L27. Ref for 'level-set method'. L28: Insert 'the' before 'fire component'.

P1762: L7: Define 'CAWFE' L8 Change to 'fire spread model of Rothermel (1972)'. L9: Change to 'Support for alternative fire spread models (e.g. Balbi'. L19: Change to 'for the first time various new developments' L20: Insert 'completed' before 'in'. Insert 'by' before 'Mandel' L21: Delete 'scattered in presentations and conference abstracts'. This implies that these "improvements" to SFIRE have not undergone peer-review prior to this submission and raises doubts as to the appropriateness of the process. L24: Is the 'real test case' an attempt at validation or is it just an example? L26: Does 'GIS' need to be defined?

P1763: L20: 'heat content'. This is actually the heat yield or low heat of combustion and should not be confused with the enthalpy. L22: 'typically 0.9'. What is this value based on? Provide refs. The value will depend on your definition of fuel load but in many cases can be as high as 1.0 and as low as 0.1 and will depend on the burning conditions

and combustion mode. To make a flat assumption here is a gross simplification of the problem. L23-25: Provide refs. See Alexander and Cruz 2012 for an example. L26: Is 'fuel' being used a plural in the brackets? Otherwise change 'burn' to 'burns'.

P1764: L1: Change to '(fast burning)' L4: Change 'concept' to 'interpretation' L6-10: How robust is this assumption of exponential fuel consumption? Are there references to support it? How is Tf determined? What values are being used? If you are only considering 63% of the combustion period, why is w0 being used? Shouldn't this also be reduced to 63% of the load? Not all of w0 will contribute to the new fireline intensity in this formulation. This will over estimate energy output, particular if, as on the previous page, w is reduced from the full fuel load w0. This interpretation of fireline still suffers from the primary deficiency of Byram's fireline intensity in that it considers the combustion of everything behind the fire front rather than a per unit area which is what reaction intensity does (but this too isn't related to fire behavior). L16-22: What is meant by 'simulated fire severity'? Severity is a measure of impact of a fire and depends on what is being impacted. It is difficult to see the utility of this quantity from this discussion, primarily because it is unclear and confusingâĂŤif you're calculating maximum fire spread in any direction, then this doesn't need a fireline as such, is this correct? Does the maximum fire spread consider all combinations of potential fire weather/fuel combinations at a point? If it doesn't then it can't be considered maximum potential rate of spread. Clarify.

P1765: L13: 'Hopefully'? Why hopefully? L26-27: '. . .the wind at the moment. . .' Do you mean as currently implemented, or the current wind speed driving the rate of spread in the simulation? Unclear.

P1766: L4: 'Here' Where? In Kondratenko et al 2011? Who's 'we'?âĂŤnot the authors of Kondratenko et al 2011? L10: Delete 'is'. L11: Insert 'an' before 'additional'. L13: What does 'plays the role of truth here' mean? Rephrase. L16: Moisture content is generally singular in regard to fuel. Change 'contents' to 'content'. L23: See L16. L24: If this model and its parameters are for dead wood, how applicable is it to determining the moisture content of fine (1 hour) fuels driving the spread of wildland fire? See recent review by Matthews (2014) for a comprehensive coverage of the different fine fuel moisture modelling approaches employed around the world. This method is a gross simplification for the purposes of simulation.

P1767: L15: Is this calibration appropriate for the conditions being simulated? L19: The values for threshold rain intensity and saturation rain intensity seem rather low. How do they compare with other values using the same model? Wouldn't these depend on other climatic variables?

P1768: L2: 'wk' is undefined. L3: Delete 'with'. L4: Change 'contect' to 'content'. L12: This is not clear. Shouldn't the averages of the state variables over two adjacent time steps be for example (E_n + E_n+1)/2? L15-16: Same as above? L21: Why couldn't the model be validated against direct measurements of fuel moisture content, rather than trying to interpret fuel moisture model performance filtered through fire spread simulation (and the huge number of assumptions and unknowns embedded therein)? Fuel moisture content is one of the easiest aspects of wildland fire to study because it doesn't need a fireâĂŤthis model must be validated using direct FMC measurements.

P1769: L11: One of the many unknowns in this case was the precise ignition locations. Another it seems is the final perimeter itself. L22-25: This is pure speculation because you could not compare it against actual fire behavior, only the simulated perimeter that had the diurnal fuel moisture changes fed into it. Figure 8 illustrates some significant problems with the fuel moisture model as implemented. See discussion below on the figure (P1791). L25-26: You haven't shown that the fuel moisture model 'renders' the diurnal variations in fire activity or that it improved the total simulated fire area. You may infer this but you haven't shown it. Over 4 days of fire spread there is plenty of opportunity for over and under predictions to cancel each other out. A very weak test.

P1770: L1-4: This is all unvalidated. L16: How are these 10 h fuel FMC values applied to 1 h fuels? It's not clear how these are modified in the simulation.

P1771: Will the results gathered here for the 10 h fuels be much different when applied to 1 hour fuels? The equilibrium times of 10 h fuels mean that they will miss much of the impact of rapid changes in atmospheric conditions such as cold fronts and troughs, etc.

P1774: L9-11: Doesn't the chemical emissions of a fire depend on the intensity of the fire in question? Are the emission factors given only fuel-type specific?

P1775: L4-10: How is this validated? L13: Where are the fire danger maps given in Section 2? In this context, how is fire danger defined? It appears all you are considering is potential fire behavior but this does not tell you anything about potential for fires to break out, their potential to spread, or their potential to do damage, which is what most definitions of fire danger incorporate. See Chandler et al 1983. L14: Where are the GIS interfaces given in Section 6? L17: Define NWS. L19: How are the forecasts downscaled? L21-22: What are the high-resolution forecasts of fires based on? Potential fire behavior? How is this defined? Worst possible given the coincident forecast weather or the worst possible given the potential combinations of forecast weather?

P1776: L1: Insert 'via a web interface' after 'interactively'. L10: 'output every 24 h'. Unclear here. Do you mean the moisture model is run once a day or every operational 1.333 km system's output for a period of 24 hours? L17: Change 'air support' to 'aerial suppression'. L27: If worst case what is the value of fuel moisture used? L29: What about areas outside of these landmarks? Are people expected to interpolate between these values? If so, is this meaningful? How are these predictions of 'fire danger' validated?

P1777: How applicable to the fuels of Israel is the Rothermel model and its operational fuel models? L5: 'is the only one running operationally'. Do you mean in Israel or around the world? It is not the only fire danger system running operationally in the world. L12: Change to 'Mandel et al. (2009, 2011a). L12-14: This is not a sentence. L15:Phrasing. 'allows now for modelling fire spread,'. It did this before. Insert 'dynamic' after 'account'.

P1778: L1: What do you mean 'renders' smoke? L2: Change 'it' to 'smoke'. L5: Change to 'not only allows the study of'. L10: PhrasingâĂŤ'rendering' L16: Phrasing –'allowing for' L17: Change 'the ignitions' to 'incorporating ignitions'. What do you mean by 'arbitrary'? As I understand it, it's not arbitrary but a fire perimeter at a given time. Phrasing 'allows for'. L18: Change 'a need for' to 'the need to'. L21: What does 'selected other components of the Earth system' mean? Clarify. L24: Ultimate you have not quantified fire danger as a whole but only one aspect of itâĂŤpotential rate of spread. Without potential for fire occurrence and potential for damage, this is not an assessment of fire danger.

P1779: L1: What other coupled fire-atmosphere models have been implemented operationally if WRF-SFIRE is 'one of the first'?

P1786 (Figure 3): The vertical axis label for 3b appears to read 'Idnition'. What do the colors mean on the right vertical axis? There are numbers but no axis title. Where are the two peaks in (b)? It is difficult to see these. Perhaps highlight them.

P1787 (Figure 4): What is 'tign' from the title for 4b? Why are the times for all the figures in UTC? If the objective is for an operational tool, output should be in local time so direct comparisons can be made against measurements in the field, particular those of fire behavior and perimeter location. Can't you quantify how similar or different the two wind fields in a) and b) are? 'quite close' is highly subjective and not very informative.

P1788 (Figure 5): Again, why display fire output in UTC? Mis-spelled 'simulation' in second line. Again, can't you quantify the differences and similarities between the two simulations? See Filippi et al (2014) for some metrics of comparison. In particular for a simulation, final fire shape alone is an insufficient metric as arrival time is also very important.

P1789 (Figure 6): The function displayed in (b) is very different to the one shown in (a).

The linear nature of the time-lag model suggests that it will under-predict Van Wagner and Pickett for nearly any rain rate and starting moisture content.

P1791 (Figure 8): The 'diurnal' oscillation of the moisture content curve does not appear to follow the actual daylight hours of the day and the subsequent maxima and minima of the rate of spread prediction appears to even further removed from what would be expected of wildland fire behavior. Assuming that the fire occurred in the Pacific Daylight Time zone (UTC -7 hours), the FMC maxima and minima seem to be around 9.00 am and 5.00 pm. Sunrise at this time year for Spokane (about 150 kms away) is 6.25 am and sunset 7.05 pm. This means that after 2.5 hours of sun, the modeled moisture is still dropping whereas in reality the MC of fine fuels follows the almost immediate rise in relative humidity following dawn.

Similarly, the minima of FMC normally occurs 3 or so hours after solar noon (in this case noon is 12.45 pm). A minima at 5.00pm is also rather late. These lags are probably driven by the use of parameters and coefficients derived from 10 hour fuels rather than 1 hour fuels. This is also evident in the values of the maxima and minimaâĂŤan absolute variation of only 9% (in some cases as low as 2% appears to grossly underestimate the true variation in moisture content particularly in late summer.

These lags in moisture content seem to be exacerbated in the lags in fire behavior. The period of active fire spread appears to commence at between 10.00 am and 1.00 pm and cease between midnight and 01:00 am. Of course this is dependent on other environmental variables but also seems to be well behind the expected diurnal variation in fire behavior. Most fires will not continue spreading so actively 5-6 hours after sunset. This is a significant issue and needs better testing and validation before it can be deployed.

P1792 (Figure 9): It is difficult to see the point of this figure without a significantly better graphic. What do the colors mean?

References Chandler, C., Cheney, P., Thomas, P., Trabaud, L. and Williams, D. 1983.

Fire in Forestry 1: Forest Fire Behaviour and Effects. John Wiley & Sons, New York, 450 pp.

Filippi, J.-B., Mallet, V. and Nader, B. 2014. Representation and evaluation of wildfire propagation simulations. International Journal Of Wildland Fire 23, 46-57.

Matthews, S. 2014. Dead fuel moisture research: 1991-2012. International Journal Of Wildland Fire 23, 78-92.

Sullivan, A. L. 2009a. Wildland surface fire spread modelling, 1990-2007. 1: Physical and quasi-physical models. International Journal of Wildland Fire 18, 349-368

Sullivan, A. L. 2009b. Wildland surface fire spread modelling, 1990-2007. 2: Empirical and quasi-empirical models. International Journal of Wildland Fire 18, 369-386.

Sullivan, A. L. 2009c. Wildland surface fire spread modelling, 1990-2007. 3: Simulation and mathematical analogue models. International Journal of Wildland Fire 18, 387-403.

Sullivan, A. and Ball, R. 2012. Thermal decomposition and combustion chemistry of cellulosic biomass. Atmospheric Environment 47, 133-141.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 1759, 2014.