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Geoscientific Model Development Discussions

Interactive comment on "WRFv3.2-SPAv2: development and validation of a coupled ecosystem-atmosphere model, scaling from surface fluxes of CO_2 and energy to atmospheric profiles" *by* T. L. Smallman et al.

Anonymous Referee #1

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This paper has two purposes: firstly to document recent developments included in the Soil Plant Atmosphere (SPA) model version as coupled to the Weather Research & Forecasting (WRF) model; and secondly to describe the effect of incorporating a different land surface model into an existing modelling framework.

The SPA is a high vertical resolution (10 canopy layers and 20 soil layers) terrestrial ecosystem model. It is complex in comparison with the majority of the land surface schemes presently coupled to atmospheric models (including NOAH default land surface in WRF). SPA couples energy, hydrology and carbon cycles. Plant phenology and carbon dynamics, as described by the Data Assimilation Linked Carbon model, are integrated into SPA to simulate carbon pools. A

crop model is also included. The paper compares the impacts of SPA and original land surface NOAH on the simulation of air temperature and turbulent fluxes at three sites in Scotland. Net ecosystem exchange and atmospheric profiles of CO2 from WRF-SPA are also presented. The paper will be of interest to the model developers, especially land surface modellers and also wider climate community interested in exploring the feedbacks between the biosphere carbon balance, meteorology and land management/use change.

Model description:

The paper provides detailed description of the recent model developments in the SPA model. The science described is of value, however the paper is not succinct and contains a number of repetitions. These need to be addressed prior to publication.

Here are a few examples that illustrate the problem:

p. 1573, second line ' sensible heat flux is based on the temperature difference ...' then on the same page following equation (24) we have 'sensible heat () is calculated based on the difference ...'

p.1573, last line 'The P-M equation is used to calculate the potential evaporation or dew formation i.e.' and then after equation (25) for Epot we have ' Epot () is potential evaporation or dew formation ..'

- Equations 26 and 27 can be folded into one: $E_{wet} \quad \lambda \quad = C_{stor}/C_{max}\ E_{pot} \quad \lambda - E_{leaf}\ \lambda$

The sentence 'Note that potential evaporation is first converted to Wm-2 by multiplying by λ' can be omitted.

- There is repeated description of some constants i.e. specific heat capacity, air density.
- The net radiation φ_n symbol can be replaced with R_n as φ is already used for stability correction term.

Results

Although the results presented cover short period (i.e. 3 years), the results appeared robust when compared to the observations. Mean annual bias, RMSE and R2 calculated for hourly

observations of air temperature, latent and sensible heat fluxes are in a similar range in both models with a few exceptions. WRF-SPA has larger RMSE but it shows robust statistics for net ecosystem exchange (NEE) which were not provided for WRF-NOAH. Mean monthly results show that both models reproduce well the observed temperature seasonality with WRF-SPA being overall closer to the observations. Seasonal NEE is reasonably well predicted by WRF-SPA at all sites. Time series of mean seasonal heat fluxes reveal differences between the two models with WRF-SPA being able to better capture the observed seasonality. A comparison of WRF-SPA modelled and observed atmospheric profiles of CO2 show the model's ability to produce realistic exchange, source/sink distribution and transport of CO2.

Other comments

Given the complexity of the SPA model, it would be of interest to see the complete list of model parameters used for these simulations.

The roughness length for the soil used in SPA is 0.01m; is this value decreased for soil under canopy with large LAI?

Some minor corrections

- p. 1577, second paragraph, second line: 'Air samples were (not where) corrected.'
- p. 1575, last paragraph, 'the mass of surface litter mass ....
- p. 1577, section 5.1, '(analysed in R2...)' proper reference required
- p. 1581, last paragraph, 'Further, there (is) presence...'
- p. 1594, figure caption, observations (of) the surface ...'

The science in this paper is sound but parts of the text need to be revised and resubmitted to improve clarity and ease of reading.

Interactive comment on Geosci. Model Dev. Discuss., 6, 1559, 2013.