

General comments

Much material has been added to the second version, and the model description has become more explicit where this is needed. However, some of the presentation of especially the new pieces needs improvement.

Some main points: Explanations (or introductions) of details are often lacking; the descriptions of radiation occur no less than three times now; there are problems with referring to figures and tables (which are sometimes not included); the descriptions of long wave radiation and of the alternative induction method are not yet intelligible. More details are given in the following.

One suggestion for the presentation was not carried out: The present lack of possible abridgements in the equations in the supplement is far from attractive, but it may be of some use if it helps the authors to check the model code, as they say.

Concerning the content, the changes seem to be in accordance with the requirements of reviewers, and the errors that were pointed out have been well corrected. New calculations have been done with updated schemes for vegetation resistances and multi-layer albedo, as asked by reviewers (we do not comment on this here).

The model seems promising, but the enormousness of the description, whilst having its advantages, makes it difficult to check everything, so in the following things may have been overlooked. Moreover, certain details may have been misunderstood in this review.

To improve the focus and readability of the manuscript., details concerning the shortwave and longwave radiation schemes have been moved to the supplementary material.

Main text, minor comments

219: Schmidt number seems to be nowhere explained.

reference added to explain Schmidt number

224 etc.: CO₂ should not be written in italic (check for other occurrences)

corrected

232: "than can": "that can"?

corrected

233: Eq. (29): check number.

corrected [Latex link to equation](#)

266 etc.: use curved d's for differentiation here (because differentiation to x,y,z is also involved, namely when the divergence is taken). Same remarks for Eqs. 17-18. Errors of this kind also occur elsewhere.

corrected

375: "+-" should be "-".

corrected

451: use of T^{t+1} contradicts the statement in line 447 that the future T has not been used; contradictory statements on this point are haunting the main text and the supplement (keywords: implicit/explicit).

Apparently the authors chose to mix temperatures for time $t+1$ through the radiative expressions, but the description of what is done is very confused (see below). Is it the purpose to use for any layer, the local $T(t+1)$ for calculating emission, whereas the $T(t)$ from the other layers is simultaneously used to calculate absorption? In that case, systematic errors might occur. This could be checked by comparing results obtained with implicit and explicit calculation method (all other things being equal).

the variation between timesteps for this longwave component is small, but this is something that could be tested further

471 (Equation 43): α is not specified for the combination of vegetation- i with $j=0$, or $j=m+1$; in the two expressions with four terms, the last term has the wrong sign; the last three expressions seem to pertain to a layer above the canopy, so their usefulness is unclear. The second and second last line may have been swapped. Not sure about the middle line, should this be $2\text{trans}(l_i)/\text{trans}(l_{i-1}) - 2$?

expression corrected (radiation section moved to supplement)

Equation 47: In the left hand side one would expect $T(t+1)$ and not $T(t)$ as written here, and the next forms

corrected

Eqs. 48,49 cannot be correct (wrong dimension).

corrected

Equation 50: Is there a factor 4 missing here?

corrected

518: "transmitted albedo" is this a good term?

phrase updated as this actually represents the fraction of light that is transmitted, rather than the albedo directly

520 etc.: a bit more information on the calculation of ψ^{collided} would be interesting, now the reader has to rely entirely on the references.

further information added

Eqs. 52-58 follow from balance considerations, and might be superfluous.

removed

Eq. 54: how is the incoming downward contribution accounted for?

equation error removed

600,602: "forced": unclear. "prescribed"?

corrected

604, 613: Table 4: has not been included, on the second occurrence Table 3 seems to be understood.

corrected

605: Strange start second sentence.

corrected

618: has a missing space.

corrected

619: Question mark for reference.

corrected

649: “smaller magnitude”: on average it seems to be a larger magnitude.

description corrected

659: Figure S3: not found.

corrected

662: “was able”: not very well...

description rephrased

662: Figure 6b/c: check consistency between text, figure and list of figures, b and c are sometimes reversed.

corrected

669, 670 et passim: check the occurrences of “positive gradient” and “negative gradient”, here the terms are used wrong, the correct definition is given in the discussion.

replaced with standard definition throughout manuscript

680-682: Reformulate.

reformulated

685: Reformulate first half.

reformulated

701: “to a standard comparable to single layer models”: is there no advance then?

corrected

701: “interative”: “iterative”?

corrected

706: “have”: “has”?

corrected

815: A redundant dot.

corrected

Figure 5e/f: have “net down-welling radiation”, but list of figures has “net radiation”.

corrected everywhere to 'net radiation'

Figure 6: remove “top of canopy” in little block.

corrected

Supplement, minor comments

Page 2, second half: here, in the equations, no curved d's but delta's should be used (the first version was in

principle correct). Curved d's should only be used in numerator/denominator pairs.

corrected

Section S2.1 has very much overlap with section 3.2, there is no need for two long pieces saying the same.

section removed, comments here clarified in equivalent section of manuscript

Eq. S2.3: Re is not explained here (though it is explained in the main text). Eq. S2.4: add subscript H. Is "r" the same as "R"?

section removed, clarified in equivalent section of manuscript

Eq. S2.5: the Schmidt number is nowhere explained fully.

section removed, reference for Schmidt number added in equivalent section of manuscript

Eq. S2.6: add subscript E.

section removed, clarified in equivalent section of manuscript

Eq. S2.8: df unexplained; form is different from the foregoing.

section removed, clarified in equivalent section of manuscript

Section S2.1, last paragraph: the information comes too late.

inconsistencies were present between the less recent explanation in the supplementary and the manuscript version. Version in the supplement removed.

Page 4, bottom: why is block italicised?

section removed

Same: There is also a question mark, and Pm is not explained.

Pm explained, BibL^aTeX error corrected

Page 5, second half, and page 6 first half: this block should be integrated better into the remainder of the text. A lot of parameters are used here without introduction. Sorry for not commenting on this in the first round.

this is from Massman & Weil (1999), as referenced, duplicated in part for completeness in the supplementary material. Now removed as it would probably be more straightforward for interested parties to refer to that work directly.

Page 10: this whole derivation can be skipped in my opinion.

removed

Page 10, first and last equation: use curved d's . Also for equation S3.13 etc. Because in all cases, chi is differentiated in several "directions".

corrected

Eq. S3.10: a "div" is missing.

corrected

Pages 11, 12: note that " $k d^2 \chi/dz^2$ " is not the same as " $(d/dz) (k d \chi/dz)$ ", and only the second expression is correct here (with curved d's).

corrected

Page 13 at two-fifth: “that the single order”: “than the single order”.

corrected

Page 13: the description of eta_2 is incomplete, it also contains things from the same layer.

corrected

Section S3.10 again uses the mysterious term “completely explicit”.

clarified

Sections S3.11 and S3.12 have very much overlap with the main text, and they also reoccur at the end of the Supplement !

description of radiation schemes removed from main text (as derived from other publications, as referenced) but retained in supplementary material for completeness and to highlight modifications.

Page 15, Equations S3.25-S3.27 : inconsistent (also dimensionally). See also the general comment on long wave radiation.

corrected

Page 15, Equation S3.28: a factor 4 missing?

yes, corrected

Page 17 etc. : subsections S3.12.1-3.12.3 have wrong numbers as they are not subsections of S3.12. Page 17, S3.38: the use of the eta's etc. has not yet been revised.

revised

Page 19 top: question marks.

BibTeX link fixed

Page 26, equations S3.81/82: these are incomplete and can better be abbreviated as

$$u_i^{t+1} = E'_i u_{i+1}^{t+1} + F'_i$$

(since E is a matrix now, the equivalent of eq. S3.81 also involved $q_{a,i+1}^{t+1}$ etc.).

After stating the meaning of u, an explanation is needed: “The reason that T_{leaf}^{t+1} is not needed as a component of u, is that it can be expressed into the other two components. For, the original expression...”

explanation added

Page 26, equation S3.83: the use of the eta's etc. has not yet been revised.

revised

Page 27: The two lines between equations S3.87 and S3.88 can be better replaced with

“... we can substitute

$$u_{i-1}^{t+1} = E'_{i-1} u_i^{t+1} + F'_{i-1}$$

This results in an expression of the form:”

suggestion implemented

Page 27: In equations S.88-90, the inverted matrix which occurs 4 times, occurs too late for all cases (it belongs at the beginning of the terms). One has to be careful because such matrices do not commute !!

corrected

Page 27: in eq. S3.88 there should be brackets around $D'_i + C'_i F'_{i+1}$

corrected

Page 36: explain the meaning and usefulness of the xi's.

added

Page 42-43: Table 1: Is this a copy of the table in the main text ? then it is redundant.

removed

General: the supplement has no figures, yet occasionally the main text refers to figures in the supplement.

supplementary figures accidentally removed from updated version, now restored.