Hydrology and Earth System Sciences Discussions

Interactive comment on "Turbulent flux modelling with a simple 2-layer soil model and extrapolated surface temperature applied at Nam Co Lake basin on the Tibetan Plateau" *by* T. Gerken et al.

Anonymous Referee #1

Received and published: 3 February 2012

The authors present an improved version of a surface model. They implemented a new algorithm to determine surface temperature, in order to allow for a better simulation of soil-cloud interactions, as the model should be coupled to a climate model in a future study. This new approach leads to a better diurnal variation of surface dynamics, as shown by a comparison to reference turbulent fluxes. The authors are aware of the fact that their new approach is highly sensitive on the initialization of the soil temperature profile. As an accurate initialization of the model can easily be taken care of during the future study, this is not a major concern in my opinion. For a more comprehensive evaluation, the sensitivity of the modified model version on other input parameters would

be desirable. The equations are described clearly, however, few more equations would be helpful to improve the understanding of the modifications made and the differences between the two model versions. The exact procedure for model initialization is not very clear as the general initialization procedure which is described in the text seems to differ slightly from the method applied by the authors for this study. The description of the model setup and model equations could be improved easily by introducing some additional explanations and few equations. The paper shows that important improvements are achievable by introducing rather simple solutions and I recommend the publication of the study after some modification.

Specific Comments:

- 10278: The description of the location of the sites with respect to the lakes is not very clear. Site 1 is close to a small lake, which is close to the Nam Co Lake: what direction (east, west ...) from site 1 are both lakes? What is the distance between lake1 and lake2? Is the lake-land breeze originating from Nam-Co Lake or from the small lake? Those questions are not important for the outcome of the study, but I guess it would be nice for the reader to get a better impression of the sites.

- 10279: I think that more days per weather conditions would be reasonable as replicates; From 10th July on UBT was under lake-land breeze effect; what about the period before? At ITP there was no lake-land breeze, at least here it could be possible to find more days with similar weather conditions that could be used as replicates; If the authors have thought about that and neglected that in favor of choosing just 4 single days, please state why replicates might not be of further help in your case

- 10279: 1: please explain the sentence "due to the generally drier conditions at ITP, surface temperature frequently drops below 0°C in the early morning hours."; 5: "less than 20 cm": was there only one temperature sensor at ITP? If not, how many and at what depths? "Less than" means closer to the surface or deeper? 20: "from two sites": THE two sites or other two sites?; 26: On 6th August at 22:00 precipitation was

measured, but only for UBT, not for ITP; Is precipitation different between the two sites even though they are in close proximity? Or is the precipitation measurement different, i.e. there was actually rainfall at ITP, which was attributed to the next day, for instance in a rain sampler? Is it valid to interpolate the daily precipitation sums at ITP according to UBT when the measured rainfalls refer to differing time periods?

- 10280: 9: Is ATHAM the atmosphere model, where Hybrid should be coupled to in the future study? This information would be nice in the introduction.

- 10281: 9: Please add two equations for latent heat flux (evaporation and transpiration) and explain which parameters were modified, why and how. Were these transfer coefficients already modified in the original Hybrid model or is this one more difference between the original and the modified Hybrid?; 17: "lower layer with 4m thickness": same setup applied for modified Hybrid model?

- 10282: 15: "for both layers" means upper layer with 10 cm and lower layer with 4 m? (which should be clear after 281-17 was modified); "no transfer of heat through lower boundary of the model, so that Tbase,2 is constant and equal to annual mean temperature": Is the seasonal cycle of soil temperature still prominent in 4m depth? If yes, I think it would be more realistic to assume a seasonal mean temperature for Tbase,2 instead of an annual mean temperature. If not, please add a reference to support your assumption; How sensitive is the model on Tbase,2? What effect would have a for instance 10% or 20% variation of Tbase,2 on the simulation results? If Hybrid is sensitive on a variation of Tbase,2 this reveals uncertainty in the simulations and should be added to Fig. 4; What is the annual mean temperature at the stations?

- 10283: 5: for a better understanding of the procedure ("by integrating Eq. (3) with Eq. (2) and solving for a2") it would be good to mention that zU = 0 and zL = d2 (at least this is what I assume)

- 10284: 3: "was modified": the exact modification and the difference to the original Hybrid is not very clear; Please add the equation for F(z) as used in the modified

Hybrid model; How is soil heat flux treated and is there a moisture dependency of soil heat transfer in the modified Hybrid?

- 10284: 10: In my opinion it would be clearer to merge 2.1 and 3.3 in one paragraph describing all observations (as there is no 2.2 in the text this needs to be changed anyway) and then clarify the exact procedure of initialization, which is not very clear to me, see following points

- 10284: 18: As Tbase,1 is taken from measurements, why is calculation of Tbase,1 from Tbase,2 described earlier? Please clarify the exact procedure used in this study and whether there are different options how to initialize the soil profile (e.g. dependent on availability of observations).

- At 3.2.1 the authors describe a way to calculate surface temperature via extrapolation (based on Tbase,2 and heat content of the soil), at 3.3 they state that temperature measurements were taken for initialization (both heat content and surface temperature) and later they discuss the theoretical parameter space of the initial surface temperature when, as I understood, surface temperature is extrapolated from Tbase,2 given different temperature profiles in the soil. To me, this is a bit confusing.

- 10285: SEWAB has been calibrated for the sites; who did the calibration (the authors?) and what parameters were optimized? (general description is sufficient)

- 10286: 3: "especially true for lake land breeze ... therefore SEWAB and Hybrid fluxes are comparatively larger than measured ones": the periods with occurring lake-land breeze were actually excluded from the comparison between modeled and observed fluxes, i.e. I don't know whether this statement is right; 18: "as the footprint of the EC system and the forcing data " Maybe better: "... of the EC system and thus also of the forcing data for the models"; "for completeness TOGA-COARE fluxes": I don't really see the benefit of including TOGA-COARE (and HM) simulations for this study, actually Fig. 5 is a bit overloaded and would be clearer without the TOGA-COARE and HM curves

- 10287: Pleas add a comment on uncertainty in initialization relative to uncertainty in the climate model Hybrid will be coupled to at the end of results and discussion or in conclusions

- 10287: 11: "periods without ECcorr were excluded": please refer to Fig. 4 and 5 in order to show an overview of the time periods with/without EB correction; 15: "when the formulation was included": was there no formulation for surface temperature before? Suggestion: "when a new algorithm for the surface temperature was implemented"; 16: Where can I see the time shift in the original Hybrid simulations?

- 10288, 6: "compared to the original Hybrid": again: where can I see that?; 10: "match closely": true for QE, even though there seem to be a time lag; for QH however, the simulated fluxes by Hybrid are almost twice the magnitude of the ECcorr fluxes; 11: "while the original Hybrid showed…": where can I see that? 18, 19: "this starts to diverge": what? The curves or the fact that Hybrid is closer to SEWAB than to EC? The wording is a bit irritating, please rephrase;

- 10289: 10: "surface temperature is purely diagnostic and dependent on [mean]T1": this dependency gets not very clear from the model description yet, as the equation for F(z) is only given for the original Hybrid

- 10290: 19: Is there no large temperature gradient between the surface and the air at measurement height and are there no strong winds at UBT? Why not?

- 10293: 10: "realistically estimate turbulent surface fluxes": turbulent fluxes are not really simulated by the soil model; the soil model provides a better surface temperature, which then results in improved turbulent fluxes

- 10300: Table1: Please add the source for the soil characteristics; how sensitive is Hybrid on those input parameters? It would be good to know whether the uncertainty in the simulations resulting from soil parameterization is comparable to the uncertainty resulting from the initialization of heat content etc. for the modified Hybrid; Vegetation

height 0.15 vs. 0.07 and lai 0.6 vs. 0.9 are different for both sites (ITP vs. UBT): is there an explanation why the grass grows higher but with lower lai at ITP? Values for lai are equal to vegetated fraction: is this a coincidence or was vegetated fraction derived from lai? Albedo for bare soil is usually different to albedo from grass, i.e. as vegetation fraction differs between the two sites there should also be a small difference in the albedo values;

- 10306: I like figure 4. But where is the dependency of Tbase,1 on [mean]T2 in the equations? What I would like to see in addition is the dependency of T0 on Tbase,2.

- 10307, 10308: the different red and blue colors are good to distinguish at the monitor but not when printed; you could use the same color for the same fluxes in both graphs as was already done for LSEWAB and then use colors that are better to distinguish

- 10307: Fig. 5: As the authors often refer to the simulation with the original Hybrid, I would recommend adding the curve here, or, if the graph gets too confusing, adding another graph for the original Hybrid simulations; ALL refers to the complete available time series: why are there gaps? Do AllEC -curves represent the time periods where EC measurements could not clearly be assigned to land or water? "All" is also used in Table3, which might be confusing, maybe it's better to use different terms

Technical Comments:

- 10276: 15: "as the more complex methods" replace by "when compared to more complex methods chosen as reference"

- 10276: 17: introduce QH and QE here in the first sentence of the introduction: "Turbulent fluxes of momentum, latent heat (QE) and sensible heat (QH), are some of the …"; 20: "as a consequence" : a consequence of what? For my understanding the sentence would be clearer without this statement

- 10277: 15: "two layer flux algorithm": two soil layers or two atmosphere layers? 18: "upper model layer": soil or atmosphere? 20: "that this is" -> "that this new approach

is"

- 10278, 9: "to measured fluxes by eddy covariance technique" -> "to fluxes measured by eddy-covariance technique" 10: "Soil-Vegetation-Atmosphere Transport (SVAT) Model" -> "surface-vegetation-atmosphere transfer (SVAT) model"; 16: I would recommend to delete "both"; comma missing after "UBT"; "eddy covariance complex" -> "eddy-covariance setup"; 18: "influence of a water table": I'm not sure whether you can say it that way; 60cm is the water table due to the influence of the ground water; 19: land-lake breeze; 22: "and the lake": which one? 25: "r" missing in volumetric; 26: delete comma following "ITP"

- 10279: 17: "due to the overcast sky . . . the lake breeze and thus the influence of the lake surface onto the atmospheric measurements was severely weakened"

- 10279: 20: ". . . forced with measured atmospheric data from UBT (Fig. 1) and ITP (Fig. 2) providing . . ."

- 10280: 4: delete "rain"; 10: feedbacks

- 10281: put symbols either all in or all not in parentheses; units: please introduce blank between single units, e.g. m s-1 instead of ms-1 and please do this throughout the whole text including tables; 9: "(QE)" not needed any more as now already introduced in introduction; 13: double "and"; 16: "of 10 cm thickness"; 22: "this is also seen" -> "can be seen" or "is obvious"; 27: "on the"

- 10282: 2: suggestion: "In order to improve the delay in diurnal flux evolution and the weak responsiveness . . . , new simulation approaches for surface temperature and heat diffusion were introduced in Hybrid.; 12: double "and"; "heat flux"; 20: "Tbase the temperature at the lower boundary of the respective layer"; 21: "so that" -> ", i.e."

- 10284: 13: "fulfills"

- 10285: 15: modeled -> modelled

C6000

- 10285: 23: "This means" -> "Consequently,"

- 10286: 5: larger than "the" measured ones; 8: "therefore we use" -> "therefore corrected fluxes are used whenever possible"

- 10287: suggestion: "Model quality was assessed by root mean square deviation (RMSD)" – next line equation for RMSD – "and a cross correlation according to the coefficient of determination R^2 "- next line equation of R^2 - "with xzy being xzy. . ."; 10: "interpolated to 10 min time steps" or "to match Hybrid time step"; 11: "periods with no energy balance corrected EC measurements available were excluded. . ."

- 10288: 7: ". . . in August there is excessive night-time surface cooling simulated by model." -> ". . . in August excessive night-time surface cooling is simulated."

- 10289: 7: double "and"; 3: delete "to atmospheric forcing"; 17: "This is due to a problem with SEWAB. . ." -> "This is due to an underestimation of the soil water content by SEWAB as 6th of August falls into a dry interval between rainy periods"; 21: "a" reduction; "instances": I'm not sure whether it can be used in this context, "cases" might be better; 25: ". . .when one would expect the best quality. . ." -> "with periods of usually higher quality. . ."

- 10290: 5: Wm^2 -> W m-2

- 10291: 5: delete "the case"; 7: double "the"; 11: mmd-1 -> mm d-1

- 10295: References: please use uniform format for titles (some titles include capital letters, others don't)

- 10300: I'd rather put "Parameter" instead of "Site" as the first row usually describes the column below; I guess "heat capacity" is soil heat capacity? Please use same symbol as in equation 3

- 10300: Table 1: use uniform upper and lower case (e.g. Surface albedo or surface albedo or Surface Albedo); decrease line spacing between "thermal" and " conductiv-

ity"; add units for field capacity and wilting point, e.g. [m3 m-3]; in caption: "description of the two sites (UBT and ITP)..."

- 10301: "in study" -> "in this study"

- 10302: Wm-2 -> W m-2

- 10303: blank missing: "...mixing ratio (q..."

- 10304: precipitation was not really measured in 30 min intervals at ITP, please change either the graph or add explanation in figure caption

- 10307: Fig. 5: t he EC system...; surface temperature is T0 in the graph, but Ts in the text

- 10309: Qh -> QH ; "Cross correlation $R^2(t)$ of simulated fluxes..." then delete parenthesis; "each of the four days simulated and for the original and modified Hybrid" means probably "each of the four days simulated with the original and modified Hybrid"

- general comment: To my knowledge there is a "-" in eddy covariance as soon as there is a third noun following like eddy-covariance technique; there is no "-" in "measured by eddy covariance"; this applies also for land-lake breeze

––––––––––––––––––––––––––––––

C6002