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Interactive comment on "Impact of spatial data resolution on simulated catchment water balances and model performance of the multi-scale TOPLATS model" *by* H. Bormann

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Author's comment on RC#1

The author cordially thanks the anonymous referee #1 for the constructive comments and the comprehensive and detailed review of the paper. The proposed clarifications and amendments will certainly improve the paper. In the following I will comment on the general and on the specific comments of anonymous referee #1.

Author's comments on the general comments (p=page, l=line):

1) pS883, l1-6: Reviewing studies which used the TOPLATS model the paper focuses more on the content of the studies than on the scale issues. A table summarizing and comparing the scale relevant characteristics of TOPLATS studies indeed could be

useful to assess the usefulness of the investigation presented in the paper. Thus e.g. information on spatial and temporal resolution as well as the length of the simulation period could be provided.

2) pS883, l7-14: The anonymous referee #1 states that the correlation analysis is not convincing as univariate correlation are analysed assuming linear correlations although it is clear that interrelations between processes and properties are highly nonlinear. Of course the referee #1 is right, hydrological processes and the process descriptions are non-linear; that is one reason why complex hydrological models have to be used to predict water fluxes of catchments with complex structure. Nevertheless local scale non-linear systems often show approximately linear reactions at regional scale (e.g. evapotranspiration and groundwater), and changes in catchment wide fluxes often can be simply derived by analysing changes in catchment properties (e.g. evapotranspiration by using plant properties). So the idea in this part of the paper was - as nonlinear relationships cannot be analysed for the huge number of computation units - simply trying to quantify “linear” contributions of changes in input data sets to the sensitivity of the whole system.

3) pS883, l15-22: The anonymous referee #1 mentions that a week point of the study is the model dependency and the limited transferability of the results to other environments. Of course the model results are model dependent; other models are expected to show different sensitivities to aggregating input data if neighbourhood relations and therefore lateral fluxes are considered in a different way. A comparative study of several models is in preparation in cooperation with other modelling groups. With respect to climate and size of the catchment the study has shown that the systematics of the results was the same for all subcatchments of the Dill which actually show different catchment properties (e.g. rainfall, land use, soils), and was also the same for the water balances of the three different land use scenarios. Perhaps the differences in the physiographic characteristics between the subcatchments should be pronounced more in detail (e.g. an additional table). But in the investigated range (e.g. 60-700km^2 catchment size,

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700-1100mm annual rainfall) the results are transferable to other catchments.

Author's comments on the specific comments (referring to page (p) and line (l) no's of the paper):

- p2184, l11: The differences in quality measures and water balance terms are addressed.

- p2184, l17-24: In this part the changes of the calculated water balances using aggregated land use scenarios compared to non-aggregated land use scenarios are analysed. A comparison between land use scenarios and current land use is not carried out. With respect to the land use scenarios only the effect of aggregation on the water balances calculated for the land use scenarios is mentioned. The idea was to use 4 different land uses for the investigation and therefore explore the influence of land use aggregation in detail. The referee #1 is merging two different parts of the abstract.

- p2185, l5: Following reference can be given for the WFD of the European union: http://europa.eu.int/comm/environment/water/water-framework/index_en.html (date of access: 7 December 2005)

- p2185, l20: The term "variability" and "distribution" both refer to the space: spatial variability and spatial distribution. The referee furthermore is right, mentioning that also other factors influence the sensitivity the sensitivity of model output to spatial resolution. The response time of a catchment in this study does not play a major role as the study focuses on long term water balances and not on the analysis of single events. The climatological variability is of course of major importance and has been analysed in other studies, e.g. by [Andreassian et al. (2001): Impact of imperfect rainfall knowledge on the efficiency and the parameters of watershed models, Journal of Hydrology 250, 206-223]. Mechanisms how to better consider spatial variability of atmospheric variables have been studied by [Running et al. (1987): Extrapolating of synoptic data in mountainous terrain and its use for simulating forest evapotranspiration and photosynthesis, Canadian Journal of Forest Research, 17, 472-483], [Thornton et

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al. (1997): Generating surfaces of daily meteorological variables over large regions of complex terrain, Journal of Hydrology, 190, 214-251] and [Wörlen, et al. (1999): Spatial extrapolation of agrometeorological variables. Agricultural and Forest Meteorology 94: 233-242]

- p2186-87: I agree with the referee #1 to include useful additional references on scale and aggregation effects into discussion.

- p2187: a short outline of the paper is already given at the end of the introduction (see p. 2187).

- p2188, l1-2: To my mind the term SVAT scheme does not require a reference as it is a broadly used expression; otherwise I skip the abbreviation.

- p2188, l16: The exponential decay of Ksat means that saturated conductivity decreases exponentially with depth.

- p 2188, l17: The term “soil water flow” should be replaced by “percolation” (being in line with table 1).

- p2188, l20-23: Plant growth is not simulated by the model. Plant growth is approximated by monthly updating plant parameters (e.g. leaf area index, plant height) to describe the seasonal development of plant properties.

- p2188, l24-25: Both, topographic index and soils topographic index are part of the original version of TOPMODEL (Beven et al., 1995). The concept of hydrologic similarity was developed by Sivapalan et al. (1987).

- p2189, l1: The expression “appropriate scales” in this context means that the model was successfully applied ranging from sites to small catchments. I will reformulate the sentence to avoid misunderstandings.

- p2189, l8-11: Endreny et al. do not analyse the effect of data aggregation on simulation results but the effects of different data accuracy. Accuracy of a digital elevation

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model is expected to decrease with increasing grid size, but the other way round a high spatial resolution must not imply a high accuracy.

- p2189, l24-25: “Ěstrongly limitĚindependent on scale” means that TOPLATS and another SVAT scheme type model could be successfully applied on tropical, subhumid catchments with sufficient data availability, but could not be successfully applied if the physiographic variability of the catchments was not covered by the available data.

- p2189, l26: The application of TOPLATS to different temporal scales will be clarified in the table on previous TOPLATS applications to be added (see comment on the 1st general comment; information on temporal resolutions and simulation periods will be provided as far as available)

- p2191, l19-20: Small areas are not shrinking, but the total area of small areas decreases.

- p2192, l3-10: Information which is provided twice in the paper will be eliminated (e.g. the method to derive soil parameters including the reference of the pedotransfer function used).

- p2192: Two performance measures were applied, first the annual water balance of the Dill catchment to close the water balance of the model, and second the model efficiency according to Nash & Suttcliffe (1970) to optimise the temporal variability of stream flow focusing on seasonal dynamics and short time variability. Applying these two quality measures, both long-term water balances as well as seasonal dynamics are covered well.

- p2193, l9-10: The grids ranging from 50m to 2000m are: 25m, 50m, 75m, 100m, 150m, 200m, 300m, 500m, 1000m, 2000m; all values will be added to the paper; of coarse the model resolution was adapted to the data resolution and also ranges from 25m to 2000m. - p2194, l6: The bias is the deviation of stream flow over the whole calibration respectively validation period (difference between observed and simulated

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stream flow).

- p2194, l21-24: The example given is the example for the upper Dill catchment (figure caption of figure 7 is correct); this will be adjusted.

- p2194, 22: The term “significant difference” is related to fig. 7; it can be seen that the differences of simulation results between the grid sizes large (1000m, 2000m) and small (25m-500m) grid sizes is much larger that between two different small grid sizes. The term “significant” is not related to a statistical test.

- p2196, 10: Evapotranspiration is negatively correlated to the topographic index. This information will be added in the text.

- p2196, 13-16: An extended discussion on the results of correlation analysis will be provided. Party the results could be expected due to different physiographic characteristics in the subbasins, party they are the results of spurious correlations. Together with table 6 further discussion of correlation analysis will be proveded, in particular on the aggregated land use classes “forest” and “agriculture” (see below). Furthermore the correlation analysis will be extended, e.g. by including catchment average plant parameters to consider changes in land use.

- p2197, 4-5: The sentence should express that both the aggregation procedure of input data itself and the model application at decreasing spatial resolution (increasing grid size) may cause changes in the simulation results, but in total both effects may counterbalance to “no change”.

- p2202: For the land use scenarios only 6 land use classes exist as the “Proland model” which generated the scenarios does not differentiate between deciduous and coniferous forest. Therefore mixed forest is composed of three different tree types which represent the current distribution of forest in the region and which contribute to average parameter values.

- p2203: The coefficient of determination is the square of the correlation coefficient.

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- p2204: Due to model constraints (too many computational units) TOPLATS could not be applied to the 25m grid for the entire Dill basin.

- p2205: Qt is the total stream flow, with respect to the model results the sum of base flow and surface runoff.

- p2206: “Forest” is the sum of coniferous forest and deciduous forest, and “agriculture” is the sum of agricultural crops and pasture. The definition will be added to the table caption. The idea behind this additional classification is to summarise land use classes which are expected to behave similarly but which show different correlation coefficients in the correlation analysis. An explanation on this will be added to the text (p 2195/2196).

- p2210: Thanks for the comment on the different terms concerning flowing water; indeed they should be clearly defined and used within the paper. (fig. 4: discharge = stream flow; fig. 5: base flow and surface runoff; fig. 7: runoff = surface runoff)

- p2212: I do not know exactly know why model efficiency is increasing from 1000m to 2000m grid size; all different input data (land use, topographic index and transmissivity) show big differences between these two aggregation levels. For me the fact is decisive that at both grid sizes the quality measure is obviously worse compared to the smaller grid sizes.

- p2217: a graph of land use for the Aar catchment can be added. Thanks for the suggestion, indeed it is slightly different compared to the other subcatchments.

Thanks to the anonymous referee #1 also for the technical corrections and notes on typing errors I did not find after having written the draft version of the paper. The comments will help to avoid misunderstandings and to clarify statements which I did not make clear in the draft.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 2183, 2005.