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Interactive comment on "New lessons on the Sudd hydrology learned from remote sensing and climate modeling" *by* Y. A. Mohamed et al.

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First, we acknowledge and appreciate the comments and criticisms made to the manuscript by the anonymous referee. We believe it will improve the quality and readability of the paper. In the followings we give a detailed reply to the given comments. The comparison of the original and modified RACMO settings has been published in an internal RACMO report, a pdf file of this report can be sent if required.

Referee: The critical point of this article is that all major information and conclusions were recently already published by the same authors in other Journals/articles: ——— ——— It should become obvious what the additional "new lessons" with respect to the other publications are and why an additional new article is justified.

Reply: The title "new lessons on the Sudd hydrology ——-" is not implying new lessons learned since the aforementioned publications, which presents results on the Sudd

evaporation and its impact on the Nile hydroclimatology. It is true that major parts of the results given in this manuscript have already been published in articles [1], [2a] and [2b]. The primary reason for this manuscript is that it includes all previous (published) results in one article. The principal difference against article [1] that here verification of the SEBAL results has been made for 3 years of different hydrometeorological conditions on the same catchment, while, in [1] the verification has been made for 3 catchments but for one year (1999).

Referee:1). ——- But again, also in [2b] no comparison between original RACMO settings and adjusted RACMO setting are provided.

Reply: It is true that no comparison of the original RACMO settings and adjusted RACMO settings are provided. However, as quoted in section 3.2 of [2b], a series of one-year runs have been made to tune the original RACMO settings to the climate condition of the Nile. The modifications made to the original RACMO settings have been reported in the text of section 3.2 of [2b]. The graphs of observation, original and modified RACMO results have been presented in an internal RACMO report (a pdf file can be sent if required). To avoid congested graphs, it has been decided to present only the final (tuned) results against observations in paper [2b].

Referee:2). ——— Using roughly 3-4 satellite images each month to derive monthly ET rates raises the question: how good is an ET estimate that arises from a satellite overpass (order of seconds) and extrapolates to a monthly value. ĚĚ

Reply: Based on some investigation in the literature and in particular the measurements of Farah et al. (2001) in an area close to our case study, it is believed that evaporative fraction during the day can approximate its 24 hour value. This is likely to be true as long as the time of the derived evaporative fraction is well before the afternoon, which is the case for almost all the NOAA-AVHRR images over the Sudd. The second extrapolation from daily to monthly values is based on the comparison to the same extrapolation of evaporation from a reference crop over the area, see Eq. (5) in [1], i.e.

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the ratio of the daily to monthly actual evaporation equals the same ratio for a the a reference crop. Here, the observed climate condition, including the cloud cover in the month has been used to compute the monthly evaporation of the reference crop. Similarly, the observed daily values were used to compute daily reference crop evaporation. Therefore, when computing the actual monthly evaporation using the above equation, the climate condition in the given month is implicitly accounted for. We believe this method to be more realistic than the assumption of constant evaporative fraction for the whole month, which is used by some researchers in the community. We admit that the (best) monthly average should be based on daily values for the whole month and not only 3 values per month. However, availability of suitable NOAA-AVHRR images and long calculation procedure were compelling to adopt this approach. We expect that the induced uncertainty to be small since the selected images were tried as best as possible to be representative, i.e., in day 5, 15 and 25, of the month, respectively.

Referee: 3). The “new lessons” obtained by extension of 1 year SEBAL ET-analysis [1] to 3 years [this article] should be elaborated. In particular the question must be raised, if calculation of “average monthly values” is sound, when the sample consists only of 3 members (i.e. the 3 years 1995, 1999, 2000).

Reply: New lessons are meant for all results on the Sudd hydrology, which were summarized in this article, and presented separately in details in [1], [2a], [2b]. We agree with the referee that a population of 3 years does not completely represent the Sudd evaporation. It might be the best possible, in view of image availability and feasibility of the calculation. Since the years were intentionally selected to represent: dry, medium and wet conditions it is hoped that they are likely to provide a good representation of the hydrometeorological condition over the Sudd.

Referee:4). The comparison between the DRA and CTL scenario (Jonglei canal scenario) seems to be the major point in publication [2a]. What is different to section 4.2 in this article? What are the new lessons?

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Reply: No major difference. The idea behind summarizing results of the Jonglei canal scenario of [2a] on this article, together with the SEBAL results, is to collect what we have learned on the Sudd hydrology in one article. This might be a useful approach considering the widely debatable discussions on the Sudd hydrology, and the varying answers to the questions: How large is the wetland? How much it evaporates? What is the impact on the regional hydroclimatology? This manuscript could provide quantitative answers to these questions using new techniques in the region.

Referee: 5). A further central question is: what is the quality of the RACMO model to reproduce precipitation in the Sudd region? RACMO is used in 50x50 km2 resolution and no comparison to the Sudd region, only to larger regions in the surrounding is given in [2b]. The three meteorological stations used, are more than around 400 km away from each other and in completely different climatological areas than the Sudd itself. It would be interesting to know whether these data are also used to feed SEBAL? How representative are these averaged station values for describing the Sudd hydroclimatology? What is the quality of RACMO to reproduce the values at these stations?

Reply: Fig. 12 in [2b] shows a comparison of the observed and computed RACMO precipitation over the Sudd, which has been cited in this article.

Unfortunately the 3 mentioned stations are the only available ground data over the Sudd. The long civil war and harsh environment over the swamps made it very difficult for the authorities from the region to have sufficient ground observations despite their historical recognition of the data importance over this area. In fact the main reason behind utilizing remote sensing data in this study is the poor spatial coverage of the ground stations in the area. The data from the 3 stations were used to feed SEBAL, while simultaneously utilizing satellite data to spatially distribute the station data over the whole image. E.g. instead of computing the net radiation at the 3 stations and then interpolate over the image, the albedo derived from SEBAL is used to spatially scale radiation monitored at the stations to the whole image.

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Since RACMO has been adjusted based on ground stations data over the Nile sub-basins: Blue Nile, White Nile, Atbara, and for different parameters: precipitation, runoff, radiation (2 stations), in addition to SEBAL data, it is believed that this would provide the best possible validation data. We think that a key point of the Sudd experiment is that we tried to couple the spatially good and temporally poor satellite results with the RACMO model, which would then provide both good temporal and spatial coverage.

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