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Dear Editor and Anonymous Referee #1,

On behalf of my co-authors, we thank you for the constructive comments and suggestions, which significantly improved the manuscript (**NO. ESSD-2022-217**) entitled "Global soil moisture storage capacity at 0.5° resolution for geoscientific modelling".

The manuscript has been revised based on the comments from editors and reviewers. A point-by-point response to the reviews with referencing to the lines of the manuscript is attached to this letter. All the changes are marked in blue in the reply.

Thank you very much for handling our manuscript. We hope that you will find it to your satisfaction and we look forward to hearing from you in the near future.

Sincerely Yours

Pan Liu
On behalf of all co-authors

Response to Reviewer #1

This paper developed global soil moisture storage capacity (SMSC) map at 0.5°×0.5° grid scale, which provide a great improvement on the further application of hydrologic model in ungagged area. The new SMSC data was generated by the joint calibration of three hydrologic model and expand to global by deep learning networks, and was evaluated in 20 watersheds from 5 different climate regions. Overall, this manuscript is reasonably organized, and I think this manuscript is acceptable for publication with minor revision.

Response:

Thank you for providing the opportunity to revise further and submit the manuscript. We have studied the comments carefully and then edited the manuscript. In the following section, we summarize our responses to the comments. We believe that our responses have well addressed all concerns.

Specific comments

1. Line 27: "SMSC[L]" to "SMSC"

Response:

We appreciate your comments.

Soil moisture storage capacity **(SMSC)** is defined as the total amount of water stored in the soil within the plant root zone, one of the essential parameters linking the atmosphere and terrestrial ecosystems in the hydrological components (Chen, 2014; Mccormick et al., 2021).

Chen, B.: Analysis of hydrologic systems at multiple spatial scales and its implications for aggregating hydrologic process, Dissertations & Theses Gradworks, 2014.

McCormick, E. L., Dralle, D. N., Hahm, W. J., Tune, A. K., Schmidt, L. M., Chadwick, K. D., and Rempe, D. M.: Widespread woody plant use of water stored in bedrock, Nature, 597, 225-229, 10.1038/s41586-021-03761-3, 2021.

2. Line 99-100: According to Table 1, "1902 to 2014" means January 1902 to December 2014, hence there are 113 years in total. But in line 100, "first year…, 80 years…, 30 years…" only 111 years in all. Besides, does it enough to have only one year warming-up period? I suggest to have 3-5 years for warming-up.

Response:

Thank you for the valuable suggestion.

The data for the first **3 years** is used for warm-up, 80 years for calibration, and the remaining 30 years for validation.

3. Line 152: Please specify the calculation method of the Em.

Response:

Thank you. E_m is the evaporation capacity of the basin, generally calculated from meteorological data (Wang et al., 2014). The E_m is calculated by the Priestly-Taylor equation (Du Bruin et al, 1979). Meteorological data are required, including the temperature, the atmospheric pressure, the humidity, and the net radiation.

$$E_m = \alpha_e \frac{\Delta}{\Delta + \gamma}(R_n - G)$$

where α_e is the so-called Priestly-Taylor parameter which is taken as 1.26 if simplified, Δ is the slope of the saturation specific humidity-temperature curve, γ is parameter of the heat of air at constant pressure, R_n is the net radiation, and G is the surface heat flux.

Wang, G., Zhang, J., Jin, J., Liu, Y., He, R., Bao, Z., Liu, C., and Li, Y.: Regional calibration of a water balance model for estimating stream flow in ungauged areas of the Yellow River Basin, Quaternary International, 336, 65-72, 10.1016/j.quaint.2013.08.051, 2014.

De Bruin H A R, Keijman J Q. The Priestley-Taylor evaporation model applied to a large, shallow lake in the Ne therlands[J]. Journal of Applied Meteorology, 898-90310.1175/1520-0450(1979)018<0898:TPTEMA>2.0.CO;2. 19 79.

4. Line 161: “SC” to “SMSC”

Response:

Thank you very much. This part is revised as follows:

where $S(t)$ is the soil humidity at the beginning of the period, $\boldsymbol{SMSC}$ is the saturated soil humidity, P is rainfall, g_1 and g_2 are the related parameters of the time-varying gain factor, where g_1 is the runoff coefficient after soil saturation, g_2 is the soil moisture influence coefficient.

5. Line 290: In figure 2(d), there is an increasing trend from -30° to -50° latitude. It’s not decreasing towards the South Pole. Could you explain it?

Response:

Sorry for the confusion. This is mainly due to the limitations from the runoff data. Because there is no available measured runoff information in the south of 50°S mainly for the land of Antarctica and the ocean. Additionally, the GRUN grid runoff product is only available form 90°N to 50°S. The range of figure 2(d) has been modified as follows:

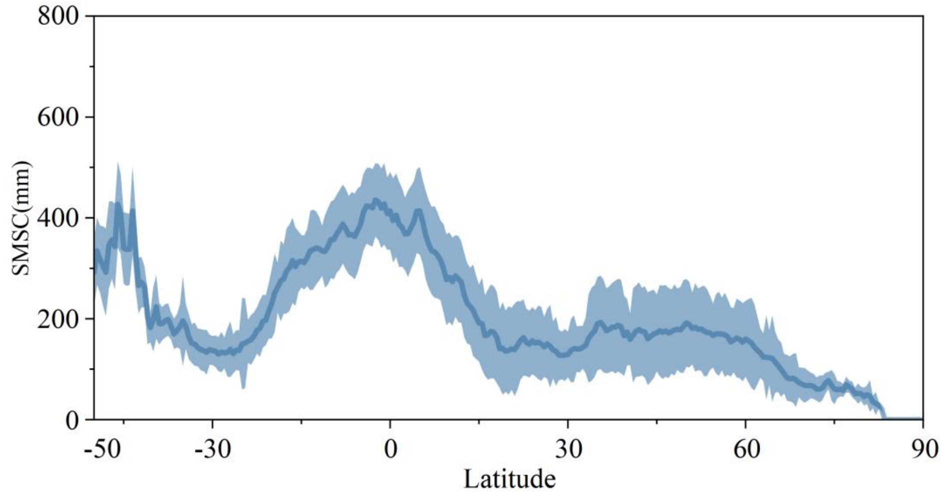

Figure 2. Spatial distribution of labels and construction results for global soil moisture storage capacity (SMSC) parameters. (d) The distribution of variations of global SMSC with latitude.

6. Line 334: “snowbelt” to “snowmelt”

Response:

Thank you. Sorry for this mistake. The sentence is revised as follows:

These three models do not take the temperature as the input, and therefore the **snowmelt** module is not considered.

7. Line 647: Table 4, could you add a column to list the climate zone of each catchment?

Response:

Thanks for your suggestions. A column is added to list the climate zone of each catchment as follows. The Köppen-Geiger climate clasification can be download in https://doi.org/10.1038/sdata.2018.214.

Table 4. Validation of global SMSC parameters in typical catchments.

Number	Site name	Longitude	Latitude	Drainage area (km^2)	Climate zone[1]	River	KGE (%) of DWBM model		KGE (%) of SWBM model		KGE (%) of TVGM model		Basin average SMSC (mm)
							Cal[2]	Val[3]	Cal	Val	Cal	Val	
1196551	Beibrug	29.99	−22.23	201001	Bsh	Limpopo	47.06	74.15	53.25	69.67	43.11	41.67	149.84
2181500	Zhimenda	96.6	33.43	137704	ET	Tongtian	49.54	72.26	69.95	77.82	84.71	80.09	121.48
2181900	Datong	117.62	30.77	1705383	Cfa	Yangtze	55.87	84.52	86.48	91.88	85.75	91.16	206.85
2260500	Sagaing	96.1	21.98	117900	Aw	Irrawaddy	78.27	76.35	70.93	68.64	63.22	56.99	365.65
2694450	Waegwan	128.39	36	11195	Dwa	Naktong	67.81	58.89	66.63	41.78	77.99	44.93	231.37
3268270	Caimancito	−64.47	−23.73	25800	Bsk	San Francisco	67.54	78.11	53.66	83.31	63.44	63.55	228.89
3618090	Cucui	−66.85	1.22	61781	Af	Negro	69.13	72.83	69.54	67.53	89.36	89.72	226.27
3624120	Gaviao	−66.85	−4.84	162000	Af	Jurua	49.13	66.07	71.06	69.88	88.35	80.24	532.84
3627030	Manicore	−61.30	−5.82	1126700	Af	Madeira	87.15	71.24	68.83	72.46	73.24	86.55	370.19
3629000	Obidos-Porto	−55.51	−1.95	4640300	Af	Amazonas	73.55	80.47	58.66	58.92	57.02	54.63	388.80
3629150	Fortaleza	−57.64	−6.05	358657	Am	Tapajos	39.03	49.10	87.55	74.90	75.24	63.62	428.36
3650745	Ico	−38.87	−6.41	12000	Bsh	Salgado	39.22	46.87	54.93	63.24	58.56	94.82	392.60
4103800	Eagle AK	−141.20	64.79	293965	Dfc	Yukon	70.56	77.55	36.05	46.80	37.01	38.99	95.21
4115100	Salem, OR	−123.04	44.94	18855	Dsb	Willamette	86.86	89.73	80.01	86.28	59.46	66.52	475.76
4115201	Beaver, OR	−123.18	46.18	665371	Dsb	Columbia	58.60	47.52	79.14	76.35	88.81	74.00	358.43
4119100	Paul, MN	−93.11	44.93	95312	Cfa	Mississippi	22.95	14.15	60.29	23.76	60.88	55.06	186.30
4146281	Verona, CA	−121.60	38.77	55040	Csa	Sacramento	43.65	64.24	70.63	60.40	89.41	88.84	344.22
5109170	Rockfields	142.88	−18.20	10987	Bsh	Gilbert	52.02	76.95	13.20	50.34	73.34	52.15	245.60
6335180	Worms	8.38	49.64	68827	Cfb	Rhine	73.97	76.66	78.43	84.00	76.88	78.37	296.07
6342800	Hofkirchen	13.12	48.68	47496	Cfb	Danube	56.53	46.58	61.31	53.67	69.49	61.30	247.41
				Mean KGE			59.42	66.21	64.53	66.08	70.76	68.16	——

[1] Köppen-Geiger climate clasification
[2] Calibration period
[3] Validation period

Beck, H.E., N.E. Zimmermann, T.R. McVicar, N. Vergopolan, A. Berg, E.F. Wood: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018).