25th International Congress on Modelling and Simulation, Darwin, NT, Australia, 9 to 14 July 2023
mssanz.org.au/modsim2023

Investigation of land evapotranspiration using CLM 5.0 model on the Tibetan Plateau

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Abstract: Tibetan Plateau (TP), known as "Asian water tower", is undergoing significant environmental changes, including accelerated melting of glaciers and frozen soil, degradation of alpine meadows and runoff changes, which has significantly changed the water cycle and ecosystem processes in the TP. Due to the global climate change, local water cycle in the TP affected by Evapotranspiration (ET) and precipitation in common. Besides, the release of latent heat regulates the balance of temperature and humidity. Under the interaction and feedback of environmental factors and ET, the water loss in the TP can't be ignored. This study firstly carried out observation research on the ET process of typical underlying surfaces in different climate regions. Improved the simulation accuracy of ET in alpine regions by improve the parameterization scheme of CLM 5.0. The CLM 5.0 was used to complete the ET simulation in the TP from 1979 to 2018. The simulation results were double verified with 12 station observation results and 4 basin water balance results, and the simulation results of different ET products were also evaluated. The temporal and spatial variation pattern and formation mechanism of ET over the TP in the past 40 years were discussed, as well as the variation characteristics of basin-scale ET.

The ET observation results of different underlying surfaces in different climatic regions were obtained, which were based on the ET and precipitation data observed by large lysimeter, the meteorological and radiation flux data observed by automatic weather station, and the energy flux data of eddy covariance system and Bowen observation system.

After improving parameters, CLM 5.0 model is better applied in the alpine meadow in Southeast TP, alpine grassland in Namco and Mustag alpine desert grassland. The Nash coefficients of the optimized model at the above stations are increased to 0.82, 0.71 and 0.75 respectively. The simulation results show that the vegetation transpiration of alpine meadow in Southeast TP accounts for 51.9% of the total ET, while soil evaporation accounts for 57.2% and 78.3% in Namco and Mustag respectively.

The spatial distribution of ET in the TP shows a decreasing distribution pattern from southeast to northwest. The lowest ET area is in the Qaidam Basin and the highest is in the southern Tibetan Valley. The results of multi-year mean annual ET show that soil evaporation accounted for 66.1% of the total ET and vegetation transpiration accounted for 26.1% from 1979 to 2018 in TP, with the multi-year mean annual ET of 335.7 mm. The total ET increased at the rate of 1.2 mm/yr, and increased significantly since 2006. As the largest proportion, the increasing rate of soil evaporation was 1.0 mm / yr.

The applicability of seven ET products was evaluated on the grid-point monthly scale and the basin annual scale. The results show that CLM shows the best simulation results on the grid scale, with the lowest simulation deviation and the highest simulation accuracy, followed by CR, and the simulation evaluation results are very close to CLM. Compared with the other six ET products, GLDAS_Noah is slightly inferior in correlation, simulation bias and simulation accuracy. At the watershed scale, GLDAS_Noah has the largest simulation deviation, while PML has the smallest simulation deviation. The annual variation of CLM, CR, ERA5_Land, GLEAM, PML and GLDAS_Noah all showed an increasing trend, while the annual ET of GLASS from 2001 to 2018 showed an insignificant decreasing.

Keywords: *Tibetan Plateau, land surface evapotranspiration, soil evaporation, vegetation transpiration, spatiotemporal variation*