Estimation of heat and water budget in Mongolia with Biosphere - Atmosphere Transfer Scheme

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1 Introduction

Estimation of the surface energy and water budget is essential to understand the climate system and climate variabilities. Land Surface Models (LSMs) have been developed to predict surface heat and water fluxes in recent two decades. This study attend to estimate the heat and water budget in Mongolia with the Biosphere - Atmosphere Transfer Scheme (BATS), one of the most widely used LSMs, and daily routine operational meteorological observation data.

2 Model description and driving data

BATS has three soil layers and uses 12 soil texture types, 8 soil color types, 18 vegetation or land cover types with partial coverage between 0.0 and 1.0. For details see Dickinson et al. (1993). Here, soil information from ftp://climate.envsci.rutgers.edu/pub/soil_moisture/MONGOLIA/ is used to assign the soil texture and soil color types. It is assumed that the depths of surface layer and root zone layer of soil are 10 cm and 100 cm, and 80% of roots distribute in the surface layer. Vegetation is assigned to short grass and vegetation coverage is assumed to be 0.8.

Daily observations of air temperature (mean, maximum and minimum), specific humidity, wind speed, precipitation pressure, sun shine duration is used. Downward solar radiation and long-wave radiation are estimated from sun shine duration, air temperature, specific humidity, air pressure with the method in Kondo and Xu (1997). To run the model with hourly time step, daily observations are interpolated into hourly interval. Downward solar radiation and air temperature are interpolated with trigonometric functions having four harmonics (Kondo and Xu, 1996). Daily precipitation is partitioned equally into the hourly interval. For other variables the diurnal cycle is assumed to be negligible and daily means are used.

3 Results

Figure shows the seasonal variations of precipitation (Pr; bars), evapotranspiration (ET; curve), snow water equivalent (SWE), soil water in surface layer (SSW) and root zone (RSW) in 1989 and 1990 at Baruun-urt, a typical grassland site. An increase in soil water is identified in spring corresponding to the decrease in SWE associated with the snow melt. This feature is more evident in 1990 and for the surface layer. It is also noteworthy that compared with 1989 the soil water in root zone stayed much high level in 1990 autumn and winter because there was a large amount of precipitation in late August and early September. In Mongolia after the ending of rainy season temperature decreases abruptly and the soil freezes in one or two months after the ending of rainy season. Therefore, precipitation anomaly may retained to the next year through the soil moisture memory. This feature is totally different with the subtropical arid and semi-arid regions.

Figure 2 shows the seasonal variation of net radiation, sensible heat flux (SH) and latent heat (LE) flux at each site. SH increases rapidly and reaches maximum in June. The peak of LE lags that of SH by one or two month.

4 Conclusion

BATS is potentially capable to estimate the surface fluxes and soil water from daily routine operational meteorological observations. To improve

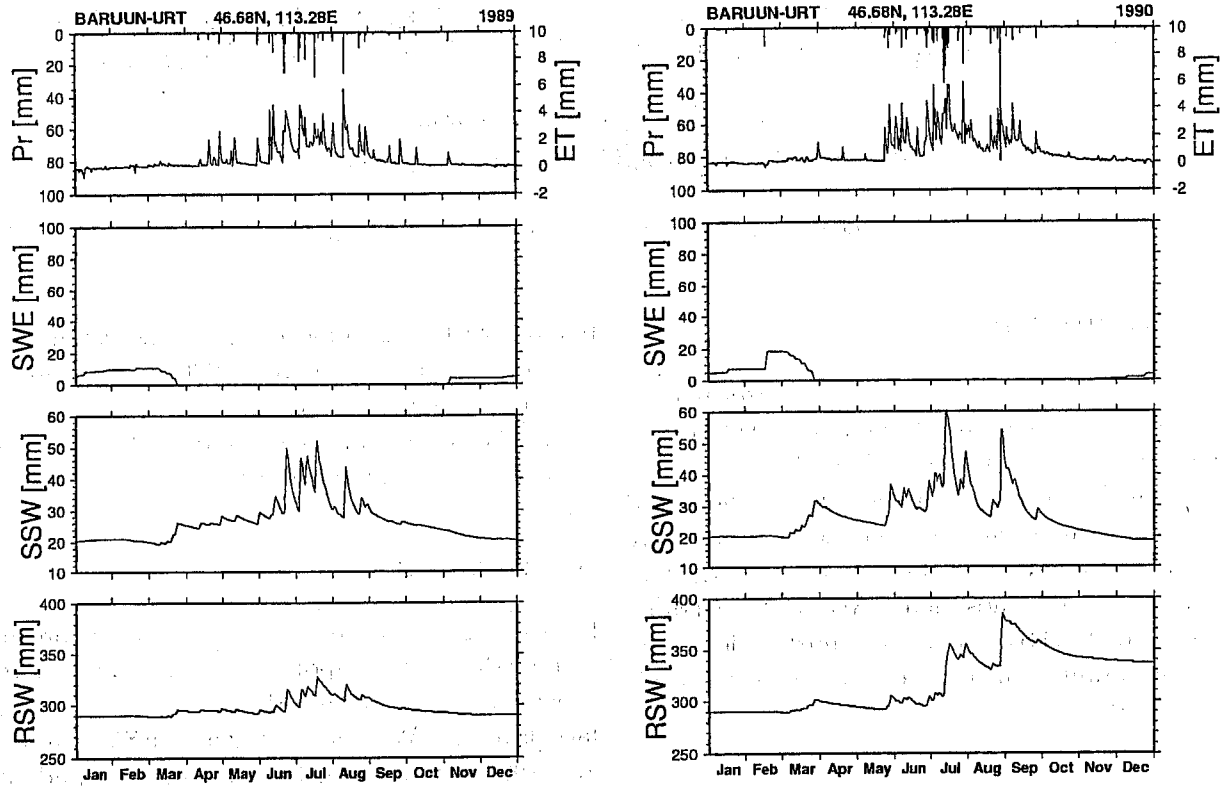

Figure 1: Precipitation (Pr, bars), ET (curve on the top panel), snow water equavlent (SWE) and soil water in surface layer (SSW) and root zone (RSW) at Baruun-urt (black dot in Fig. 2).

the estimation precision validation and calibration with realistic boundary conditions and detailed in situ observations of surface fluxes and soil water, soil temperature.

References

1. Dickinson, R.E., A. Henderson-Sellers and P.J. Kennedy (1993): Biosphere-Atmosphere Transfer Scheme (BATS) version 1e as coupled to the NCAR community climate model, NCAR Tech. Note NCAR/TN-387+STR, 72pp.

2. Kondo, J. and J. Xu (1996): An estimation of heat balance for arid and semi-arid regions in China (1): Climatological conditions, soil parameters and calculation method, J. Japanese Soc. Hydrol. Water Resour., **9**, 162-174 (in Japanese).

3. Kondo, J. and J. Xu (1997): Seasonal variations in the heat and water balances for non-vegetationed surfaces, J. Appl. Meteor., **36**, 1676-1695.

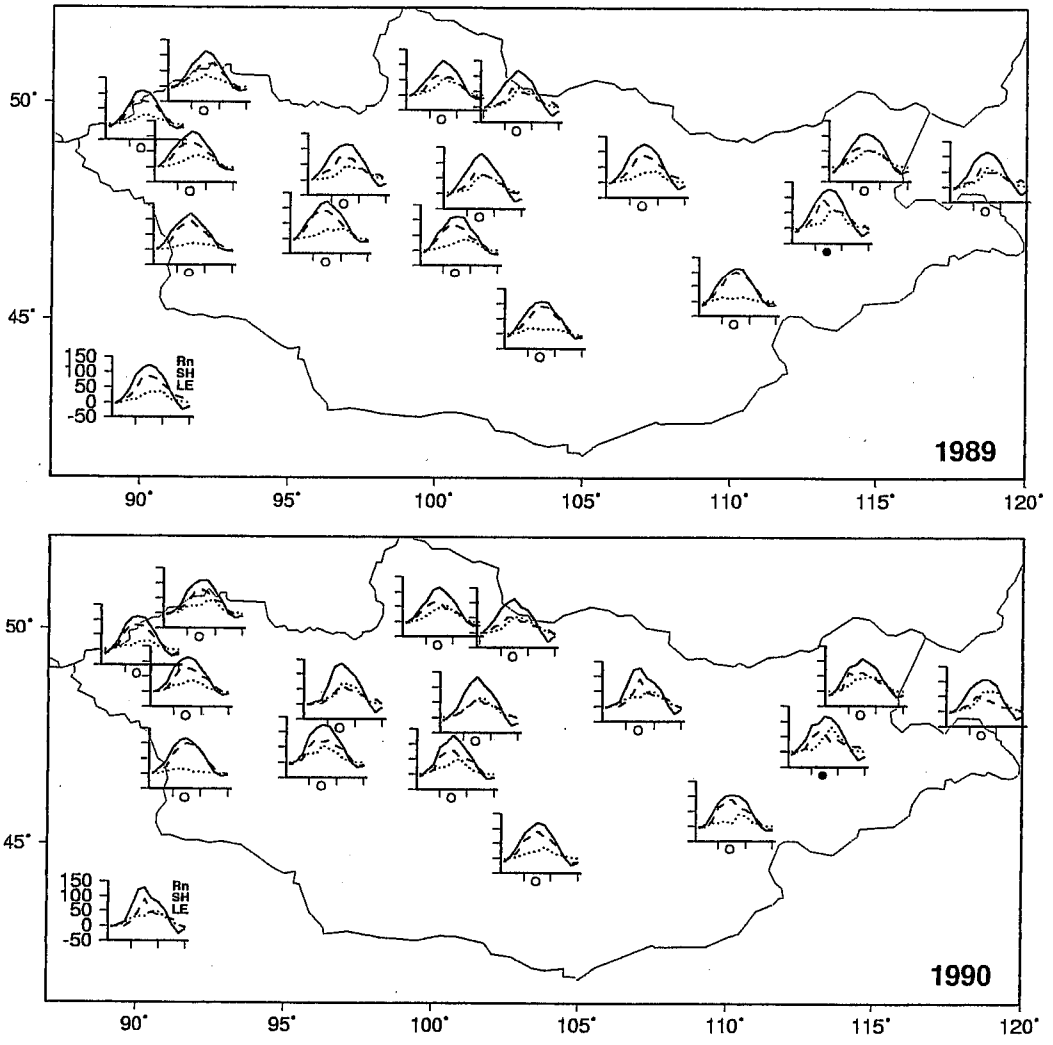

Figure 2: Seasonal variation of net radiation (Rn), sensible heat (SH) and latent heat (LE) fluxes.