Geophysical Research Abstracts
Vol. 20, EGU2018-4056, 2018
EGU General Assembly 2018

Derivation and validation of a sigmoid generalized complementary function with physical constraints

Songjun Han (1) and Fuqiang Tian (2)

(1) State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin, China Institute of Water Resources and Hydropower Research, Beijing 100038, China, (2) Department of Hydraulic Engineering, State Key Laboratory of Hydro-science and Engineering, Tsinghua University, Beijing 100084, China

The generalized complementary function to estimate actual evaporation, namely, the ratio of actual evaporation (E) to Penman potential evaporation (E/Epen) as a function of the proportion of the radiation term in Epen, E/Epen=f(Erad/Epen), has been increasingly recognized. Existing analytical forms of the generalized complementary function can be classified into three types: linear (advection–aridity model of [Brutsaert and Stricker, 1979]), approximately concave (Brutsaert, 2015), and sigmoid (Han et al., 2012). These functions are limited by improper boundary conditions resulting from inadequate understanding of physical constraints.

In this study, its zero- and first-order boundary conditions were rigorously derived by adopting the physical constraints for E in Penman's combination theory, and a sigmoid feature of relationship between E/Epen and Erad/Epen was derived. Minimum and maximum limits of Erad/Epen were introduced based on the derived boundary conditions, and accordingly a new sigmoid function was developed. By restricting it to be approximately equivalent to the linear advection–aridity [Brutsaert and Stricker, 1979] function under normal environments, the new sigmoid function satisfied the upper limits of Penman's open water evaporation and Priestley–Taylor's minimal advection evaporation in parallel. The sigmoid feature and the new sigmoid function were validated by tower based data from FLUXNET. This work improves our understanding of the complementary principle, and the new function demonstrates a favorable potential for use in evaporation estimation.

References:

Brutsaert, W., 2015. A generalized complementary principle with physical constraints for land-surface evaporation. Water Resour. Res., DOI: 10.1002/2015wr017720.

Brutsaert, W. and Stricker, H., 1979. An advection-aridity approach to estimate actual regional evapotranspiration. Water Resour. Res. 15(2), 443-450.

Han, S., Hu, H. and Tian, F., 2012. A nonlinear function approach for the normalized complementary relationship evaporation model. Hydrol. Process. 26(26), 3973-3981.