Potential Evapotranspiration Module Parameter Sensitivity Evaluation within the Next Generation Water Resources Modeling Framework

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I. Introduction

PET Module

Potential evapotranspiration (PET) is an important component in land-surface hydrologic model. The Next Generation Water Resources Modeling Framework (NextGen, Ogden et al., 2021) includes a module for calculating the PET with five standard methods:

- Option1: Energy Balance Method (Chow et al., 1988)
- Option2: Aerodynamic Method (Chow et al., 1988)
- Option3: Combination Method (Chow et al., 1988)
- Option4: Priestley-Taylor Method (Chow et al., 1988)
- Option5: Penman-Monteith Method (Allen et al., 1998)

This Study

II. Default PET parameter configuration resulted in unrealistically large numbers

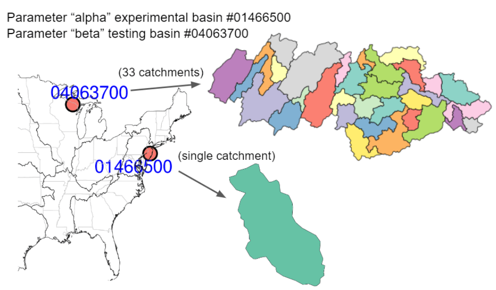


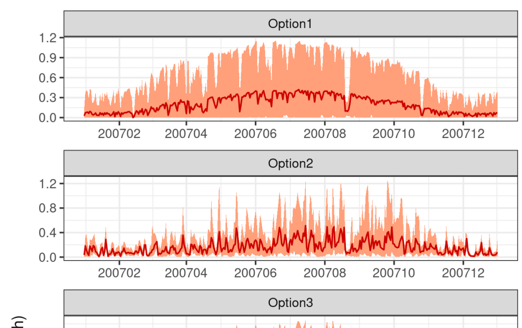
Figure 1. Two CAMELS basins for this study: the single-catchment basin #01466500 and multi-catchment basin #04063700.

Description

III. Parameter & function modification brought PET back to realistic ranges

Description

1. Adjusted parameter configuration:
   - zero_plane_displacement_height_m (d) = 0.001
2. Converted z_{om} function variable from h_c to d:
   - $// d = ⅔ * h_c$
   - $z_{om} = 0.1845 * d$
   - $z_{oh} = 0.1 * z_{om}$
3. Results:
   - The unrealistically large PET ranges of options 2 (aerodynamic), 3 (combination) and 5 (Penman-Monteith) seen in Fig. 2 decreased to be comparable to the options 1 (energy balance) and 4 (Priestley-Taylor) in Fig. 3.
   - The converted functions z_{om} and z_{oh} added the energy balance pattern to the diurnal cycles for the option 5 (Penman-Monteith) (Figs 4 and 5).
   - The apporaches tested applicable for the multi-catchment basin (Fig. 6) and multi-year (Fig. 7) simulations.



IV. Roughness height highlighted

- For a simulation basin, a proper roughness approximation is crucial and it affects the PET overall ranges (Fig. 8). While the mathematical constraints can avoid modeling the undefined output, they should not be needed if we follow the physical assumptions to configure (Table 1).
- A simulation basin often contains multiple land-cover types including local terrain, landscape, topography, vegetation, etc. (Fig. 9). Obtaining optimal parameters is a comprehensive procedure.

V. Concluding remarks

- This study illustrates the key role of roughness height it plays in adjusting PET ranges for the aerodynamic, combination and Penman-Monteith methods, and how to configure the relevant PET parameters properly within NextGen.
- Approximating the roughness height for a simulation basin may need to integrate multiple land-cover types and test parameter configuration; the roughness height function of vegetation height may not be applicable and it should be smaller than both wind and humidity measurement heights; and it is highly recommended to reference Table1 for range check when configuring the PET module parameters.
- While the roughness height largely affects the PET overall magnitude, the momentum and heat transfer parameters seem to influence the interplay between the energy balance and aerodynamic pattern in the Penman-Monteith diurnal cycles, their function variable needs to be consistent.

ABSTRACT CONTACT AUTHOR