A comparison of 4 empirical potential evapotranspiration (PET) equations performed with the DeltaLINK Simulator

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Abstract

This poster describes how the GP2 Data Logger's Script Editor and Simulator features, were used to compare 4 empirical evapotranspiration equations. This powerful new Script Editor function enables the user to quickly apply and review mathematical functions, models and experimental methods. This capability may help users to plan and develop experimental programmes prior to time consuming experimental work. Potential applications are numerous, including: the calculation of evapotranspiration, irrigation control and disease prediction. In the simulator work shown below we demonstrate added functionality (that can be installed into the GP2 Logger and Controller) that uses solar radiation, air temperature and relative humidity data to estimate PET.

Applying the GP2 to calculate potential evapotranspiration (PET)

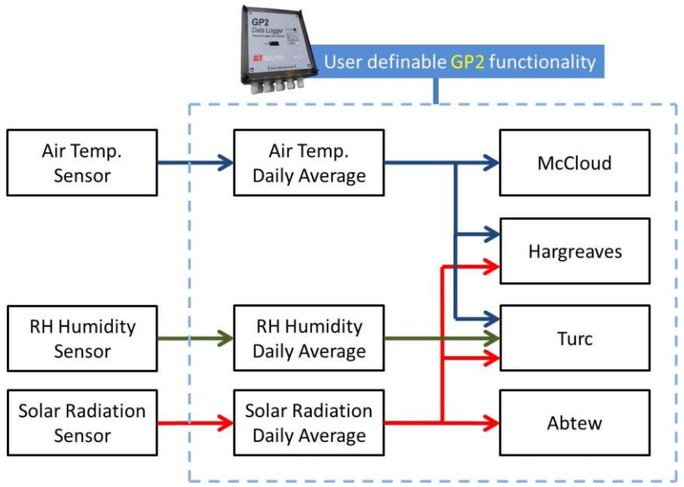

Fig 1 – Block diagram showing PET models implemented.

- **McCloud** [3]
  - Temperature-based PET model
- **Hargreaves** [2]
  - Solar radiation and temperature based PET model
- **Turc** [2]
  - Solar radiation, temperature and relative humidity based PET model
- **Abtew** [2]
  - Solar radiation-based PET model

- **Measurement units:**
  - Air temperature: °C
  - Relative Humidity: %RH
  - Solar radiation: W/m^2
  - Potential Evapotranspiration (PET): mm/day

- **Measurement intervals:**
  - Air temperature, relative humidity & solar radiation: 5 minutes
  - Potential Evapotranspiration (PET): Daily

PET calculations implemented using DeltaLINK Script Editor

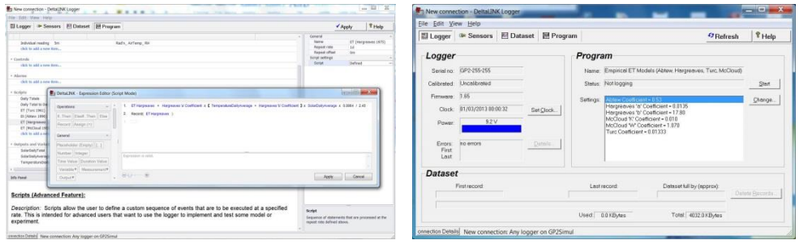

Fig. 2 – Screen shot of PET implementation in DeltaLINK 3.0's new Script Editor for the GP2 (left) and the adjustable PET coefficients (right).

The evaluation of potential evapotranspiration (PET) models

DeltaLINK 3.0 Script Editor and Simulator features were used for this comparison of 4 empirical potential evaporation equations. These mathematical models [2,3] were implemented using the new Script Editor, which allows the user to create their own sequence of operations. We used this ability to calculate daily average values for air temperature, relative humidity and solar radiation which were then used with empirical models to estimate potential evapotranspiration. A sample of the Simulator output is shown in Figure 3 below. From this data it can be seen that the solar radiation based models are well grouped and follow a similar trend whilst the temperature based PET model (McCloud) appears to overestimate PET.

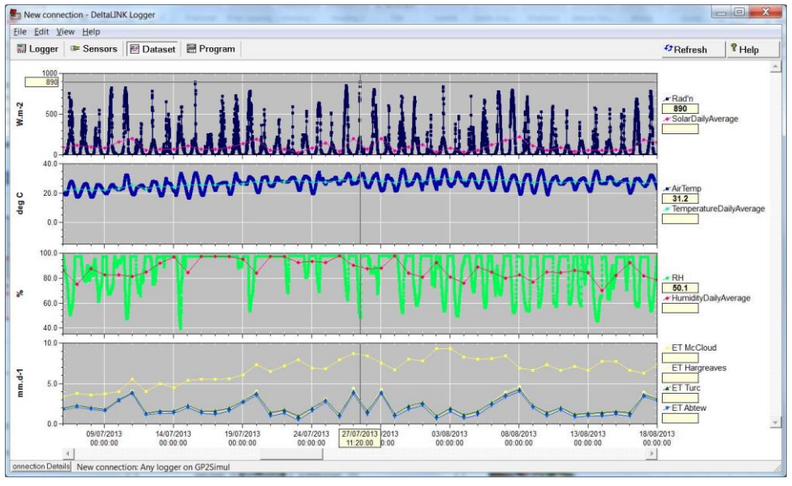

Fig. 3 – The data generated by DeltaLINK over a simulated 42 day period.

DeltaLINK Simulator output

The data created during the simulation is recorded by the DeltaLINK software and can be exported to spreadsheets for further processing. In Figures 4 & 5 Excel has been used to compare radiation (and temperature) based models with McCloud's temperature based model.

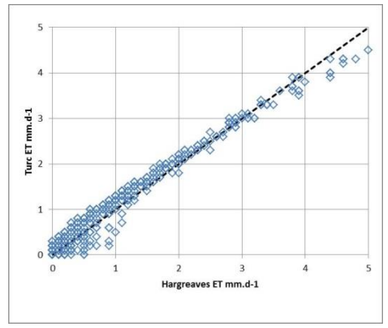

Fig. 4 – Comparison of radiation & temperature based models (Turc & Hargreaves)

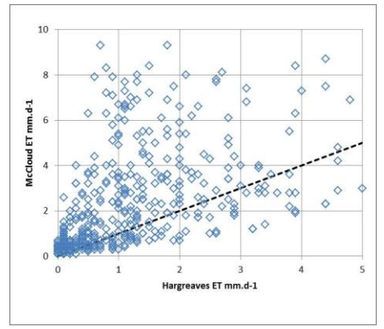

Fig. 5 – Comparison of a temperature based model (McCloud) with a radiation & temperature based model (Hargreaves)

Conclusions

The simulator feature enables the user to quickly apply and review mathematical functions, models and experimental methods. This capability may help users to plan and develop experimental programs prior to time consuming experimental work.

This comparison study demonstrates the new DeltaLINK 3.0 software's ability to simultaneously evaluate 4 empirical potential evapotranspiration models. The Simulator has enabled the comparison of solar radiation-based PET models with a temperature-based model (McCloud) to show similar trends to the experimental data presented by Irmak et al. where the FAO56-PM ET reference was employed [1].

The empirical PET models described here can be installed into a standard GP2, and with the appropriate sensors, used to calculate real-time estimates of PET. If comparison pan evaporation or lysimeter data is available then the model coefficients can be adjusted on the GP2 to optimise the model for local conditions [2].

References

1. Irmak S., Allen R. G. & Whitty E.B., 2003, Daily grass and Alfalfa-reference evapotranspiration estimates and Alfalfa-to-grass evapotranspiration ratios in Florida, *J. Irrg. Drain Eng.*, 129(5), 360-370
2. Xu C.-Y. & Singh V. P., 2001, Evaluation and generalization of radiation-based methods for calculating evaporation, *Hydrol. Process.* **14**, 339-349
3. Xystrakis F., Matzarakis A., 2011. Evaluation of 13 Empirical Reference Potential Evapotranspiration Equations on the Island of Crete in Southern Greece. *J. Irrg. Drain Eng.*, April, 211-222.

For more information regarding this and other GP2 Script Editor applications please contact: sales@delta-t.co.uk

DeltaLINK 3.0 including the Simulator is available free of charge at www.delta-t.co.uk