Simple Spreadsheet Exercise of Water Balance Simulation

In this computer exercise we will estimate net groundwater input to an alpine lake using the water balance equation. It is based on Hood et al. (2006, *Geophysical Research Letters*, 33, L13405).

The water balance equation of a lake is;

$$I_G - O_G = \Delta V/\Delta t - Pcp + ET - I_S + O_S \quad (1)$$

Lake area (A) is a function of water level (h) in general, but in this simple example we assume that A is constant at 0.26 km^2.

Your data set contains lake water level h (m) with respect to a local benchmark, daily precipitation P (mm), estimated daily evaporation E (mm), and daily average stream inflow I_S (m^3 s^{-1}) and outflow O_S (m^3 s^{-1}). Note that there are four inflow streams, and I_S is the total of all four streams.

(a) For 03/06/2005 (Row 3), calculate the volumetric rate of precipitation Pcp (m^3 s^{-1}) falling on the lake by multiplying P by the lake area:
$Pcp = P$ mm × 0.001 m mm^{-1} × (0.26 × 10^6 m^2) / 86400 s (2)
In terms of cell formula, Eq. (2) can be written as:
H3 = D3*0.001*C3*1e6/86400

(b) Similarly, calculate the volumetric rate of evaporation ET (m^3 s^{-1}) leaving the lake surface by multiplying E by the lake area:
$ET = E$ mm × 0.001 m mm^{-1} × (0.26 × 10^6 m^2) / 86400 s (3)
In terms of cell formula, Eq. (3) can be written as:
I3 = E3*0.001*C3*1e6/86400

(c) Calculate the rate of storage change:
$\Delta V/\Delta t$ = (Change in water level between June 3 and June 4) × (0.26 × 10^6 m^2) / 86400 s
Or in terms of cell formula,
J3 = (B4 – B3)*C3*1e6/86400

(d) Calculate the net groundwater flow rate $I_G - O_G$ from Eq. (1) using the cell formula:
K3 = J3 – H3 + I3 – F3 + G3

(e) Repeat the same calculation up to October 17 (Row 139) by copying the cell formula.

(f) Plot the time series of h on a chart.

(g) Plot the time series of I_S and $I_G - O_G$ on a single chart, compare it with the water level chart from (f). Discuss the seasonal trends of these variables.