1. Consider an ocean basin as illustrated above. The depth to the seafloor is given by

\[ d(t) = d_r + \frac{2 \rho_m \alpha_v (T_m - T_0) \kappa}{(\rho_m - \rho_w) \kappa} \cdot c \sqrt{t} = d_r + c \sqrt{t} \]

where \( d_r \) is the water depth at the ridge, \( \rho_m \) is mantle density (3300 kg m\(^{-3}\)), \( \rho_w \) is water density (1000 kg m\(^{-3}\)), \( \alpha_v \) is the volumetric thermal expansion coefficient (3 \cdot 10^{-5} ^\circ K^{-1}), \( T_m - T_0 \) is the temperature between mantle and surface (1300 ^\circ K), and \( \kappa \) is the thermal diffusivity (1 mm\(^2\) s\(^{-1}\)).

The half-spreading rate \( u \) was originally 3 cm/yr, but was then abruptly increased to 4 cm/yr at \( t = 0 \) m.y. This increase will lead to changes in the ridge volume and hence to changes in mean sea level.

a) What was the subduction age before the change in plate motion? What will it become when all the old seafloor has subducted?

b) Plot the basin configuration at 0, 20, 40, and 60 m.y. since \( t = 0 \) on the same plot.

c) Assuming the basin width remains fixed at \( L = 4000 \) km, calculate the relative sea level change \( \Delta h(t) \) as a function of time since the spreading increase. [Hint: you must split the integral into two separate parts (before and after the change)].

d) Plot the sea level increase versus time from \( t = 0 \) to 60 m.y.

e) What is the total sea level change when equilibrium is reached?

f) What is the mean heat flux coming out of the seafloor before and after the change (after the old seafloor has subducted).