An equation for runtime based on application number of base and radiation times

\[ T_{\text{total}} = N_x (T_a + T_b + T_d + T_r) + N_{\text{itr}} (T_{G,\text{base}} + T_{C,\text{itr}}) + N_{\text{read}} T_{C,\text{rad}} + T_{\text{com}, \text{Physics}}(P_x, P_y, N_x, N_y, N_z) + P_x P_y \]

Where:
- \( N_x \): total number of timesteps
- \( N_{\text{base}} \): number of base and radiation timesteps
- \( N_{\text{itr}} \): number of solver iterations
- \( T_{G,\text{base}} \): time for non-iterative part of solver code and time per iteration
- \( T_{C,\text{itr}} \): time for physics1 for base and radiation timesteps
- \( T_{C,\text{rad}} \): local data size
- \( P_x \): processor decomposition

Collecting profiling information
- From the UM timers we can derive a mean time per grid point, per timestep for each section.

Communications
- Identify patterns e.g.
  - halo-exchanges
  - reductions along polar rows
- Where and how often they occur
- Message sizes
- Times

Computations
- The total runtime can be expressed as:

\[ T_{\text{total}} = N_x (T_a + T_b + T_d + T_r) + N_{\text{itr}} (T_{G,\text{base}} + T_{C,\text{itr}}) + N_{\text{read}} T_{C,\text{rad}} + T_{\text{com}, \text{Physics}}(P_x, P_y, N_x, N_y, N_z) + P_x P_y \]

Breaking down into sub-timestep components
- Atmospheric science (atm_step)
  - A: init
  - B: filters
  - C: atm_phys1
- Advection
  - D: advection
  - E: atm_phys2
- Diffusion
  - F: diffusion
- Helmholz
  - G: helmholtz
- Updates
  - H: updates
- Aerosols
  - I: aerosols

Exploring variation over timesteps
- Plotting the section times for each timestep of a 3 day run, we can see how the section times change.

Based on the total runtime we can categorise timesteps into:
- Base
- Radiation

Exploring variation with resolution
- We can use statistics from these runs for the number of iterations per timestep:
- N48: 9.3, 10.8, 20.2, 27.7, 29.8
- N96: 3, 4, 11, 13, 19
- N216: 28, 15, 27, 82, 71
- N320: 19
- N512: 1782

Putting together a model of the model
- The total runtime can be expressed as:

\[ T_{\text{total}} = N_x (T_a + T_b + T_d + T_r) + N_{\text{itr}} (T_{G,\text{base}} + T_{C,\text{itr}}) + N_{\text{read}} T_{C,\text{rad}} + T_{\text{com}, \text{Physics}}(P_x, P_y, N_x, N_y, N_z) + P_x P_y \]