**Instructions on how to run the Framework Model (v1.5) in MATLAB**

In v1.0, the main run function is frameworkmodel.m, which requires input arguments of temperature (in 0C), sunrise and sunset times (in the 24-hour format), CO2 level (in kPa which is about one tenth of a ppm), light intensity (in micromol m-2 s-1), genotype (1 for Ler, 2 for Col) and probability of leaf appearance (0-1).

In v1.5, wrapper.m is used to run frameworkmodel\_v1\_5.m for one or more climate matrices, allowing temperature dynamics to be incorporated.

A few parameters that should be calibrated to experimental data:

1. Water content (line 734 in frameworkmodel\_v1\_5.m)
2. Flowering time, which can be adjusted by changing the threshold value of *FT* in the frameworkmodel\_v1\_5.m (line 60 for Ler and line 70 for Columbia).

A few aspects of framework model v1.0 were adjusted to improve simulations of growth rate in dynamic temperature conditions. Ideally, these should be replaced with biologically meaningful relationships in future iterations:

1. The relationship between Specific Leaf Area (SLA) and temperature (lines 593 to 606 in frameworkmodel\_v1\_5.m)
2. The relationship between respiration and temperature (line 24 in mainres.m).

FM v1.5 LTP+GE is the default model in which temperature influences both gene expression and leaf tissue production. The different model variants can be used by doing the following:

1. FM v1.5-GE (gene expression only): Uncomment line 687 in frameworkmodel\_v1\_5.m
2. FM v1.5-LTP (Leaf tissue production only): Un-comment lines 30 to 32 and 62 to 70 in flowering\_RHS\_CO\_SVP.m to make *FT* transcription insensitive to temperature changes

A couple of other notes that we came across as we were working with these models.

1. The broken-stick function used to model leaf production rate does not seem to hold for long-lived plants (as in short-day-grown plants) at least once our new models were incorporated.
2. Although the framework model allows for changing light levels, v1\_5 is very sensitive to light level changes as this affects leaf area, so if different light levels are desired, additional calibration will likely be needed.
3. The beta function used to model *FT* levels across leaves and plants of different ages seems to oscillate. It was necessary to artificially bind it once it reached its minimum value, otherwise *FT* in the leaves was overestimated.

MATLAB-file directory:

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| **File name** | **Remark** |
| allocation.m | Component for carbon allocation in the carbon dynamic model |
| assimilation.m | Component for carbon assimilation in the carbon dynamic model |
| clock\_RHS.m | ODE for the circadian clock portion of the photoperiodism model |
| diagnosic\_photoperiodism\_mod\_vs\_obs.m | Calls extract\_model\_dynamics\_multiday.m to allow comparison between dynamics of a given molecular output on a given day to observed data for model diagnostics |
| extract\_model\_dynamics\_multiday.m | Extracts dynamics of a given molecular output for a given day and over several days for model diagnostics |
| flowering4bcjac.m | Jacobian for the ODE solver |
| Flowering\_RHS\_CO\_SVP.m | ODE for flowering gene expression portion of the photoperiodism model, also includes temperature influence on CO and SVP |
| frameworkmodel\_v1\_5.m | Main run function file |
| ini\_carbon\_balance.m | Initialisation of the carbon dynamic model |
| link\_clock\_flwr.m | ODE solver to entrain the photoperiodism (clock) model prior to actual start-time to determine the stable limit cycle |
| mainres.m | Component for maintenance respiration in the carbon dynamic model |
| organdemand.m | Component for organ demand in the carbon dynamic model |
| parameter.mat | Parameter values for all except the photoperiodism model |
| phenology.m | Main run function for the photothermal model |
| photosynthesis.m | Photosynthesis component (the Farquhar model) in the carbon dynamic model |
| plant\_carbon\_balance.m | Main run function for the carbon dynamic model |
| sublink\_clock\_flwr.m | ODE solver for subsequent time points |
| translocation.m | Translocation component in the carbon dynamic model |
| vpaper.mat | Parameter values for the photoperiodism model |
| wrapper.m | Used to run frameworkmodel\_v1\_5.m against dynamic light and temperature conditions and plot various diagnostic outputs |
| wthr\_[…].txt | Index files for the meteorological data. Note: set lights on (dawn) to time 0 if comparing molecular outputs to observed time courses (dawn set as ZT0) |

The main function files for the existing models are highlighted in orange. Note that the functional-structural plant model is embedded within the main framework model. Accumulation of *FT* with leaf growth is also included in the framework model.