

+ *Implementation of DynamicPhenology4 (DP4):* This method allows estimating the start of the leave fall. Required new parameters in the land-use table are (with examples):

- method = DynamicPhenology_4; # the new method code
- DP4_t0_dorm = 304; # 1.11.=304/305 # starting day (Julian day number),
chilling units will be summed up after this day of year
- DP4_t1_dorm = 32; # 01.02.=32 # starting day (Julian day number),
forcing units will be summed up after this day of year
- DP4_T0 = 9; # threshold temperature for chilling units (if T < T0)
- DP4_T1 = 4; # threshold temperature for forcing units (T > T1)
- DP4_Par_a = 1748; # tree specific parameter
- DP4_Par_b = -317; # tree specific parameter
- DP4_T_xylstop = 10; # threshold temperature, the moving average of
temperature has to stay below for 5 days in order to
start leave fall
- DP4_t_xs1 = 183; # time of year (Julian day number), the moving
average analysis starts from (for start leave fall estimation)
- DP4_SPSLF = 5; # (SamplePointStartLeaveFall) sample point ID which
is replaced by the day of start leave fall with the
original value as latest time

The following sequence from the control file shows the coding of the Julian day sample points:

```
JulDays = 15 74 -1 +28 268 310 349;
Albedo = 0.25 0.25 0.25 0.25 0.25 0.25 0.25; # albedo (snow free)
rsc = 90 90 90 55 55 90 90; # leaf surface resistance [s/m]
AltDep = 0.025 0.025 0.0 0.0 0.0 0.0 -0.025; # altitude dependency [days/m]
```

The starting day for unfolding leaves is marked by a -1 in the JD-list. It is calculated using forcing units after

$$T_S = \Sigma(T_{avg} - T_1)$$

For each day exceeding the temperature T_1 (which is DP4_T1), the T_S value is incremented by T_{avg} (the daily average of temperature) minus T_1 . The critical value of T_S is calculated by

$$T_{S,crit} = a + b \ln(C_D)$$

Here, a and b are the parameters DP4_Par_a and DP4_Par_b, respectively. C_D is the number of days between DP4_t0_dorm and DP4_t1_dorm when $T_{avg} < DP4_T0$.

The beginning of the leave fall in autumn is estimated by a moving average of temperature (7 days average). If this value is falling below DP4_T_xylstop for at least 5 subsequent days, the leave fall phase will start. This estimation starts only after DP4_t_xs1 was reached (so that no leave fall will take place in spring already when temperatures may be low, too). To synchronize the Julian day table with the result of this moving average evaluation, the index in the JD-table for which the start leave fall date is valid must be given as parameter DP4_SPSLF. In the example above, this is 5. So the JD with value 268 will be replaced by the day calculated by the moving average analysis. However, the given value (of e.g. 268) is also a maximum allowed value. So, if the moving average of temperatures didn't reach the threshold of 5 subsequent days until the Julian day given in this table, then the JD-value there will be taken as start leave fall date and no moving average will be evaluated further. The length of the next phenologic phase (leave fall) is taken from the difference between the JDentry with index DP4_SPSLF and the next one (in the above example 310-268 = 42 days).

Note 1: Since DP4_t0_dorm is usually November, 1st, the model will switch to DP1-Method when the model run starts after this day but before DP4_t1_dorm. Only the following years will be handled by DP4 then. So it's a good idea to start the first model year in November, already.

Note 2: It's a good idea to set altitude correction (AltDep) for the sample points which are dynamically calculated (the one with -1 and its successor as well as the DP4_SPSLF and its successor) to 0. Otherwise the model may behave unforeseeable.