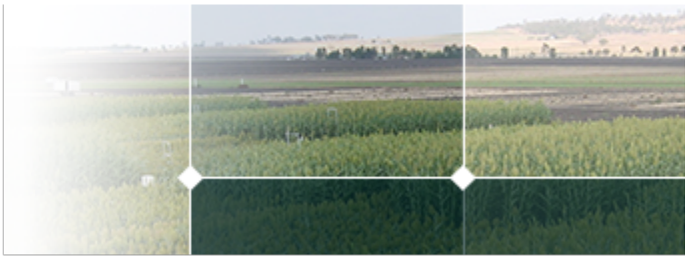


1 The APSIM Eucalyptus Model

1.1 Eucalyptus Model Notes

1.2 Plant Modelling Framework

The APSIM Eucalyptus model has been developed using the Plant Modelling Framework (PMF) of Brown et al., 2014 within APSIM Next Generation Holzworth et al., 2014. This new framework provides a library of plant organ and process submodels that can be coupled, at runtime, to construct a model in much the same way that models can be coupled to construct a simulation. This means that dynamic composition of lower level processes and organ classes (e.g. photosynthesis, leaf) into larger constructions (e.g. maize, wheat, eucalyptus) can be achieved by the model developer without additional coding.

##Pecularities of Eucalyptus and This Model

The Eucalyptus model consists of:

* a phenology model to simulate development through sequential growth phases
* a collection of organs to simulate the various plant parts
* an arbitrator to allocate resources (N, biomass) to the various plant organs

This work builds upon earlier APSIM forest models such as described by Huth et al., 2002,Huth et al., 2001 and Huth et al., 2008.

Eucalyptus is a reasonably straight forward perennial crop to model. This model has been set up for simulation of even-aged plantations (transplanted seedlings) or native forests (also assumed to start the simulation as a transplanted seedling, but in practice it would be sown from naturally distributed seed). Plants grow in accordance with available resources and conditions, which in this version of the model are temperature, radiation, available soil water, and available soil nitrogen. Leaves, branches and roots senesce, remain attached for some time, then detach to produce litter. Above-ground biomass is the main target of production, which is made up of organs that develop from default partitioniing targets that are modified daily in response to organ demand. Forest managers also deal with tree size, which are set in the model as empricial functions of aboveground biomass. During model development, we found that Eucalyptus model performance (plant or stand development) was particularly sensitive to leaf lifespan/longevity, specific leaf area, dead leaf detachment, partitioning to roots and shoots, mortality and thinning, and weeds (if present).

After stem dry weight is determined, it is then empirically split into bark and wood (based on individual stem weight), and the volumes of each set using bark thickness. This enables under and over bark properties to be calculated for BA, Vol and MAI, and finally a the calculation of wood and bark densities. Volume is calculated as a stand rather than summing individual trees. Many of these attributes of stem metrics are highly site, genotype and management specific, and some forestry plantation companies keep there own parameterisations confidential.

There are many Eucalyptus genotypes (species, closely related genera, provenances, families, clones, and hybrids) that can behave differently in response to their growing environment. The Eucalyptus model was calbirated on datasets of species (E. globulus, E. grandis, E. nitens, E. saligna), hybrids (E. grandis x E. urophylla, E. globulus x E. urophylla), and two clones of the E. grandis x E. urophylla hybrid.

##Including a Eucalyptus crop in an APSIM simulation

A example Eucalyptus simulation is available by clicking the "Open an Example" tab available when APSIM Next Gen is opened. This provides a demonstration of how to simulate a Eucalyptus crop, and it provides some useful graphs as suggestins for viewing model behaviour and performance.

To incluce a Eucalyptus crop in a simulation the "Eucalyptus" model needs to be added to the paddock, field or zone in which it is to be grown. This can be done by (a) right clicking on the "Paddock", selecting "Add model..." then "PMF", then selecting "Eucalyptus" from the list that comes up, or (b) copying and pasting the model from the example simulation. A TreeSowingRule needs to be set up to start the crop. Harvesting and replanting are included in the 'EucalyptusRotation' example.

This document provides a more detailed description of the model, describes the validation and test datasets, and model performance.

Major Eucalyptus model developments:

2017-2019

- Developed and released the first version of the Eucalptus model in APSIM Next Generation. That verison was based on Australian and Brazilian datasets covering tropical and sub-tropical genotypes - mainly E. grandis. Publications include Smethurst et al., 2020 and Elli et al., 2020.

2020-2022

- Included temperate species, i.e. E. globulus and E. nitens.
- Included an expansion of stem metrics beyond just diameter at breast height (DBH, cm), height (m), and overbark stem volume (Vol, m^3/ha). New stem metrics include underbark parameters of stem volume (Volub) and wood density, and basal area (BA, m^2/ha) the mean annual increment of overbark and underbark volumes (m^3/ha/year).This required partitioning of stem biomass into bark and wood, calculation of bark thickness, and an estimation of volumes overbark and underbark. All stem metrics are empricially calculated rather than process-based. These metrics are known to be highly effected by stem taper, bark thickness and wood density, which in-turn are highly influenced by site, genetics and management. Few data are available on wood density (underbark, whole tree), so it is included here only as a check that underlying calculations are sensible. Validations of these metrics are included. In comparison, it remains that only DBH, height and overbark stem volume are validated for the tropical and sub-tropical genotypes.

Suggested future developments:

1. Create a set of functional weeds specifically for use with these forestry models, e.g. N-fixing/non-N-fixing X herbaceous/shrub/tree X tropical/sub-tropical/temperate.
2. Coppicing
3. Self-thinning rule or process-based mortality
4. Improve effects of stocking, if necessary. Leaf allocation as a function of aboveground.wt (g/m^2) rather than individual tree weight (g/tree) has been included, but further checking of this is required to see that if that is all that is needed for a wide range of stockings.
5. Waterlogging – I (Philip) would have thought it was important, particularly for some euc and pine genotypes, but so far I haven’t run into a really need for it amongst our current observed datasets.
6. Add observed data for the tropical and sub-tropical genotypes for the more advanced stem metrics, and recalibrate the model for those genotypes if necessary. This would be a good postgrad project for a Brazilian student with industry collaborators.
7. Soil P (and K) and fertiliser responses
8. Pruning and effects on knot-free wood (wood quality)
9. Geo-locate and interact adjacent plots for predicting area-based metrics like stream flow and wood production
10. `Tree and log size class distributions`
11. Development of outputs for greenhouse accounting (water use, C sequestration, greenhouse gases, biodiversity idiexes)
12.

The model has been developed using the Plant Modelling Framework (PMF) of Brown et al., 2014. This new framework provides a library of plant organ and process submodels that can be coupled, at runtime, to construct a model in much the same way that models can be coupled to construct a simulation.This means that dynamic composition of lower level process and organ classes(e.g.photosynthesis, leaf) into larger constructions(e.g.maize, wheat, sorghum) can be achieved by the model developer without additional coding.

The model is constructed from the following list of software components. Details of the implementation and model parameterisation are provided in the following sections.

List of Plant Model Components.

Component Name	**Component Type**
Age	Models.Functions.AccumulateFunction
MortalityRate	Models.Functions.Constant
Phenology	Models.PMF.Phen.Phenology
Arbitrator	Models.PMF.OrganArbitrator
IndividualTreeLiveWt	Models.Functions.DivideFunction

Component Name	Component Type
IndividualTreeStemWt	Models.Functions.DivideFunction
Leaf	Models.PMF.Organs.PerennialLeaf
Branch	Models.PMF.Organs.GenericOrgan
Stem	Models.PMF.Organs.GenericOrgan
CoarseRoot	Models.PMF.Organs.GenericOrgan
FineRoot	Models.PMF.Organs.Root
RootShootRatio	Models.Functions.DivideFunction

1.3 Memo

Root:shoot ratio, and allometric relationships for height (Ht, m), stem diameter (DBH, cm, over bark at 1.3 m height), and their derivatives (stem volume Vol, and mean annual increment MAI) were developed as a function of above-ground biomass from Almeida, 2003, Almeida et al., 2004, Borges, 2009, Cromer et al., 1993, and Nogueira, 2005. Similarly, above-ground biomass as a function of stem weight or wood weight was developed from the same datasets plus Turner, 1986, Byrne, 1989, Bradstock, 1981, Polglase et al., 1995, Snow et al., 1999, Snow et al., 1999, Myers et al., 1996, Myers et al., 1998, and Melo et al., 2015.

1.4 Age

Age = Accumulated *day* between emergence and old

This converts days of growth to age in years.

day = 0.0027397260273972603 (years)

1.5 MortalityRate

MortalityRate = 0

1.6 Phenology

The phenological development is simulated as the progression through a series of developmental phases, each bound by distinct growth stage.

1.6.1 ThermalTime

ThermalTime = 1 (^od)

List of stages and phases used in the simulation of crop phenological development

Phase Number	Phase Name	Initial Stage	Final Stage
1	Germinating	Sowing	Germination
2	Emerging	Germination	Emergence
3	Juvenile	Emergence	EndJuvenile
4	Mature	EndJuvenile	Maturity
5	Declining	Maturity	Old
6	Old	Old	Unused

1.6.2 Germinating

The phase goes from sowing to germination and assumes germination will be reached on the day after sowing or the first day thereafter when the extractable soil water at sowing depth is greater than zero.

We make no distinction between sowing and transplanting in this model, but all sites used transplants not sown seeds. Initial weights are specified for leaf (1 g/plant) and fine root (0.2 g/plant), which implies these are transplants. Germinating and emerging phenology phases are included in case they are needed by later users. No planting shock is included, but this could be considered in future versions, e.g. delay in commencement of root downward growth.

1.6.3 Emerging

This phase goes from germination to emergence and simulates time to emergence as a function of sowing depth. The *ThermalTime Target* for ending this phase is given by:

Target = *SowingDepth* x *ShootRate* + *ShootLag*

Where:

ShootRate = 0 (deg day/mm),

ShootLag = 1 (deg day),

SowingDepth (mm) is sent from the manager with the sowing event.

Progress toward emergence is driven by thermal time accumulation, where thermal time is calculated as:

ThermalTime = [Phenology].ThermalTime

1.6.4 Juvenile

This phase goes from emergence to endjuvenile.

The *Target* for completion is calculated as:

Target = 365 (^o)

Progression through phase is calculated daily and accumulated until the *Target* is reached.

Progression = 1 (^od)

1.6.5 Mature

This phase goes from endjuvenile to maturity.

The *Target* for completion is calculated as:

Target = 1825 (^o)

Progression through phase is calculated daily and accumulated until the *Target* is reached.

Progression = 1 (^od)

1.6.6 Declining

This phase goes from maturity to old.

The *Target* for completion is calculated as:

Target = 27010 (^o)

Progression through phase is calculated daily and accumulated until the *Target* is reached.

Progression = 1 (^od)

1.6.7 Old

It is the end phase in phenology and the crop will sit, unchanging, in this phase until it is harvested or removed by other method

1.6.8 Constants

ThermalTime = 1 (^od)

1.6.9 StageCode

1.6.9.1 StageCode

A value is linearly interpolated between phenological growth stages

1.7 Arbitrator

1.7.1 Arbitrator

The Arbitrator class determines the allocation of dry matter (DM) and Nitrogen between each of the organs in the crop model. Each organ can have up to three different pools of biomass:

* **Structural biomass** which is essential for growth and remains within the organ once it is allocated there.
* **Metabolic biomass** which generally remains within an organ but is able to be re-allocated when the organ senesces and may be retranslocated when demand is high relative to supply.
* **Storage biomass** which is partitioned to organs when supply is high relative to demand and is available for retranslocation to other organs whenever supply from uptake, fixation, or re-allocation is lower than demand.

The process followed for biomass arbitration is shown in the figure below. Arbitration calculations are triggered by a series of events (shown below) that are raised every day. For these calculations, at each step the Arbitrator exchange information with each organ, so the basic computations of demand and supply are done at the organ level, using their specific parameters.

1. **doPotentialPlantGrowth**. When this event occurs, each organ class executes code to determine their potential growth, biomass supplies and demands. In addition to demands for structural, non-structural and metabolic biomass (DM and N) each organ may have the following biomass supplies:

* **Fixation supply**. From photosynthesis (DM) or symbiotic fixation (N)
* **Uptake supply**. Typically uptake of N from the soil by the roots but could also be uptake by other organs (eg foliage application of N).
* **Retranslocation supply**. Storage biomass that may be moved from organs to meet demands of other organs.
* **Reallocation supply**. Biomass that can be moved from senescing organs to meet the demands of other organs.

1. **doPotentialPlantPartitioning.** On this event the Arbitrator first executes the DoDMSetup() method to gather the DM supplies and demands from each organ, these values are computed at the organ level. It then executes the DoPotentialDMAllocation() method which works out how much biomass each organ would be allocated assuming N supply is not limiting and sends these allocations to the organs. Each organ then uses their potential DM allocation to determine their N demand (how much N is needed to produce that much DM) and the arbitrator calls DoNSetup() to gather the N supplies and demands from each organ and begin N arbitration. Firstly DoNReallocation() is called to redistribute N that the plant has available from senescing organs. After this step any unmet N demand is considered as plant demand for N uptake from the soil (N Uptake Demand).
2. **doNutrientArbitration.** When this event occurs, the soil arbitrator gets the N uptake demands from each plant (where multiple plants are growing in competition) and their potential uptake from the soil and determines how much of their demand that the soil is able to provide. This value is then passed back to each plant instance as their Nuptake and doNUptakeAllocation() is called to distribute this N between organs.
3. **doActualPlantPartitioning.** On this event the arbitrator call DoNRetranslocation() and DoNFixation() to satisfy any unmet N demands from these sources. Finally, DoActualDMAllocation is called where DM allocations to each organ are reduced if the N allocation is insufficient to achieve the organs minimum N concentration and final allocations are sent to organs.

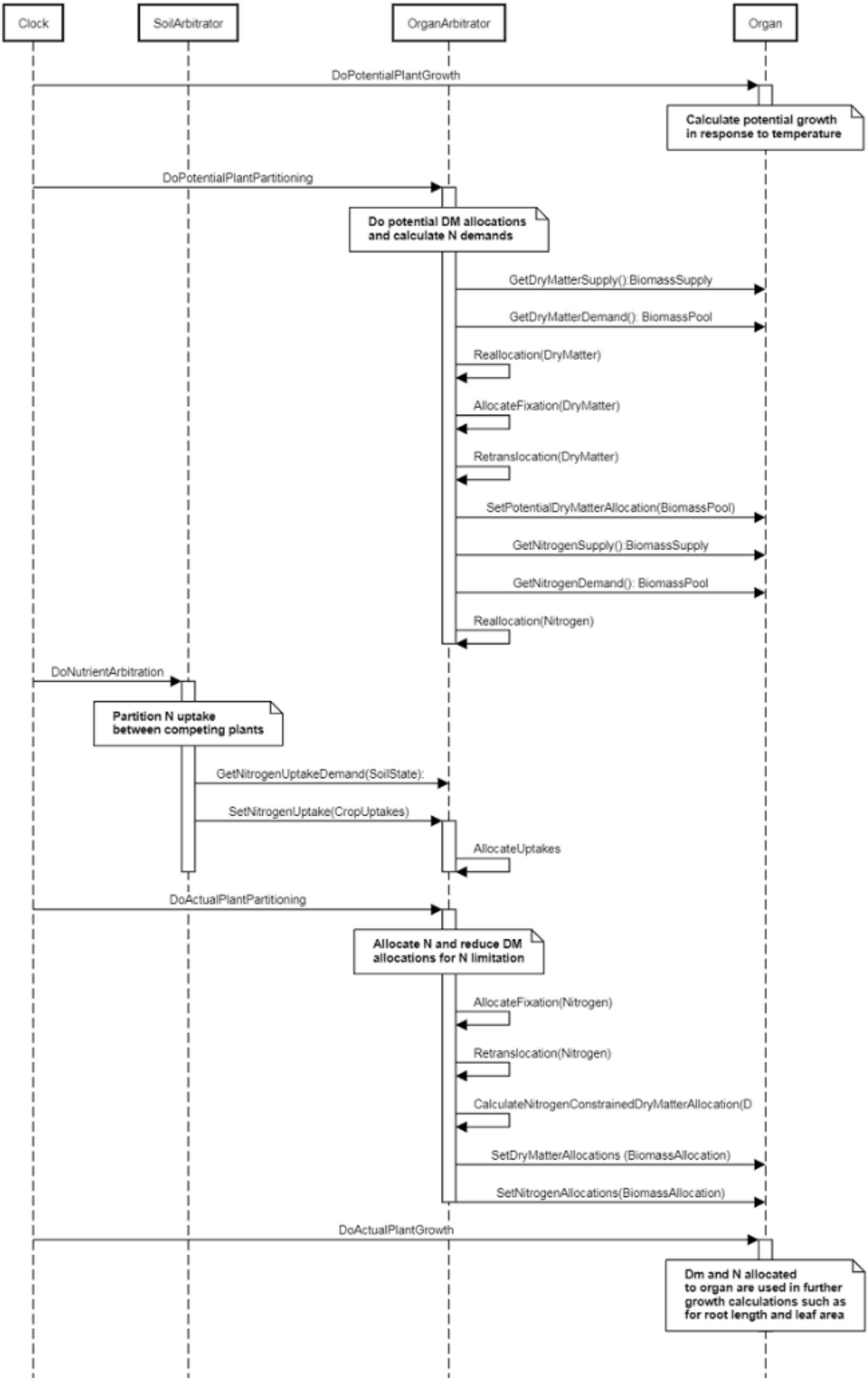

Clock
SoilArbitrator
OrganArbitrator
Organ
DoPotentialPlantGrowth
Calculate potential growth in response to temperature
DoPotentialPlantPartitioning
Do potential DM allocations and calculate N demands
GetDryMatterSupply():BiomassSupply
GetDryMatterDemand(): BiomassPool
Reallocation(DryMatter)
AllocateFixation(DryMatter)
Retranslocation(DryMatter)
SetPotentialDryMatterAllocation(BiomassPool)
GetNitrogenSupply():BiomassSupply
GetNitrogenDemand(): BiomassPool
Reallocation(Nitrogen)
DoNutrientArbitration
Partition N uptake between competing plants
GetNitrogenUptakeDemand(SoilState):
SetNitrogenUptake(CropUptakes)
AllocateUptakes
DoActualPlantPartitioning
Allocate N and reduce DM allocations for N limitation
AllocateFixation(Nitrogen)
Retranslocation(Nitrogen)
CalculateNitrogenConstrainedDryMatterAllocation(D
SetDryMatterAllocations (BiomassAllocation)
SetNitrogenAllocations(BiomassAllocation)
DoActualPlantGrowth
Dm and N allocated to organ are used in further growth calculations such as for root length and leaf area

Figure 1: Schematic showing the procedure for arbitration of biomass partitioning. Pink boxes represent events that occur every day and their numbering shows the order of calculations. Blue boxes represent the methods that are called when these events occur. Orange boxes contain properties that make up the organ/arbitrator interface. Green boxes are organ specific properties.

1.8 AboveGround

1.8.1 AboveGround

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

AboveGround summarises the following biomass objects:

* Branch
* Leaf
* Stem

1.9 BelowGround

1.9.1 BelowGround

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

BelowGround summarises the following biomass objects:

* FineRoot
* CoarseRoot

1.10 StemAndBranch

1.10.1 StemAndBranch

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

StemAndBranch summarises the following biomass objects:

* Stem
* Branch

1.11 Total

1.11.1 Total

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

Total summarises the following biomass objects:

* Leaf
* Stem
* Branch
* FineRoot
* CoarseRoot

1.12 TotalLive

1.12.1 TotalLive

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

TotalLive summarises the following biomass objects:

* Leaf
* Branch
* Stem
* FineRoot
* CoarseRoot

1.13 TotalDead

1.13.1 TotalDead

This is a composite biomass class, representing the sum of 1 or more biomass objects from one or more organs.

TotalDead summarises the following biomass objects:

* Leaf
* Branch
* Stem
* FineRoot
* CoarseRoot

1.14 IndividualTreeLiveWt

Note that this property does not include branches. It is used in calculating DM Demands of several plant components.

IndividualTreeLiveWt = [Eucalyptus].Aboveground.Wt / [Eucalyptus].Population

1.15 IndividualTreeStemWt

IndividualTreeStemWt = [Eucalyptus].Stem.Wt / [Eucalyptus].Population

1.16 Leaf

This organ is parameterised using a simple leaf organ type which provides the core functions of intercepting radiation, providing a photosynthesis supply and a transpiration demand. It also calculates the growth, senescence and detachment of leaves.

1.16.1 Constants

LaiDeadFunction = 0 (m$^{2/m}$2)

MinimumLAI = 0.01 (m$^{2/m}$2)

ExtinctionCoefficientDead = 0.5

Foliar N concentrations are based on Leuning et al., 1991.

MaximumNConc = 0.03 (g/g)

This is an assumed value.

MinimumNConc = 0.01 (g/g)

A value of zero assumes there is no N reallocation.

NReallocationFactor = 0 (/d)

DMConversionEfficiency = 1 (g/g)

A value here is the number of days between senseence and detachment. A value of 14 days is assumed.

LeafDetachmentTime = 14 (d)

A value for DetachmentRateFunction is required in Leaf, Branch, Stem and CoarseRoot components of the model, but a zero value means that immediate detachment has been triggered. A non-zero option might be useful in the future for defining some genotypes.

The same explanation applies to zero values below for retranslocation factors.

DetachmentRateFunction = 0 (/d)

DMRetranslocationFactor = 0 (/d)

NRetranslocationFactor = 0 (/d)

This value is based on Ribeiro et al., 2015.

CarbonConcentration = 0.45 (g/g)

1.16.2 CO2internal

CO2internal = (163 - [IWeather].MeanT)/(5 - 0.1x[IWeather].MeanT)

1.16.3 StomatalConductanceCO2Modifier

StomatalConductanceCO2Modifier = [Leaf].Photosynthesis.FCO2 / *RelativeCO2Gradient*

RelativeCO2Gradient = ([IWeather].CO2 - [Leaf].CO2internal)/(350 - [Leaf].CO2internal)

1.16.4 InitialWtFunction

InitialWtFunction = *InitialPlantWt* x [Plant].Population

This value is nominally low to reflect the dry weight of leaves on a transplanted seedling.

InitialPlantWt = 1 (g/plant)

1.16.5 FRGRFunction

FRGRFunction = Min(*FT*, *FN*, *FVPD*)

Where:

FT = [Leaf].Photosynthesis.FT

FN = [Leaf].Photosynthesis.FN

FVPD = [Leaf].Photosynthesis.FVPD

1.16.6 ExtinctionCoefficient

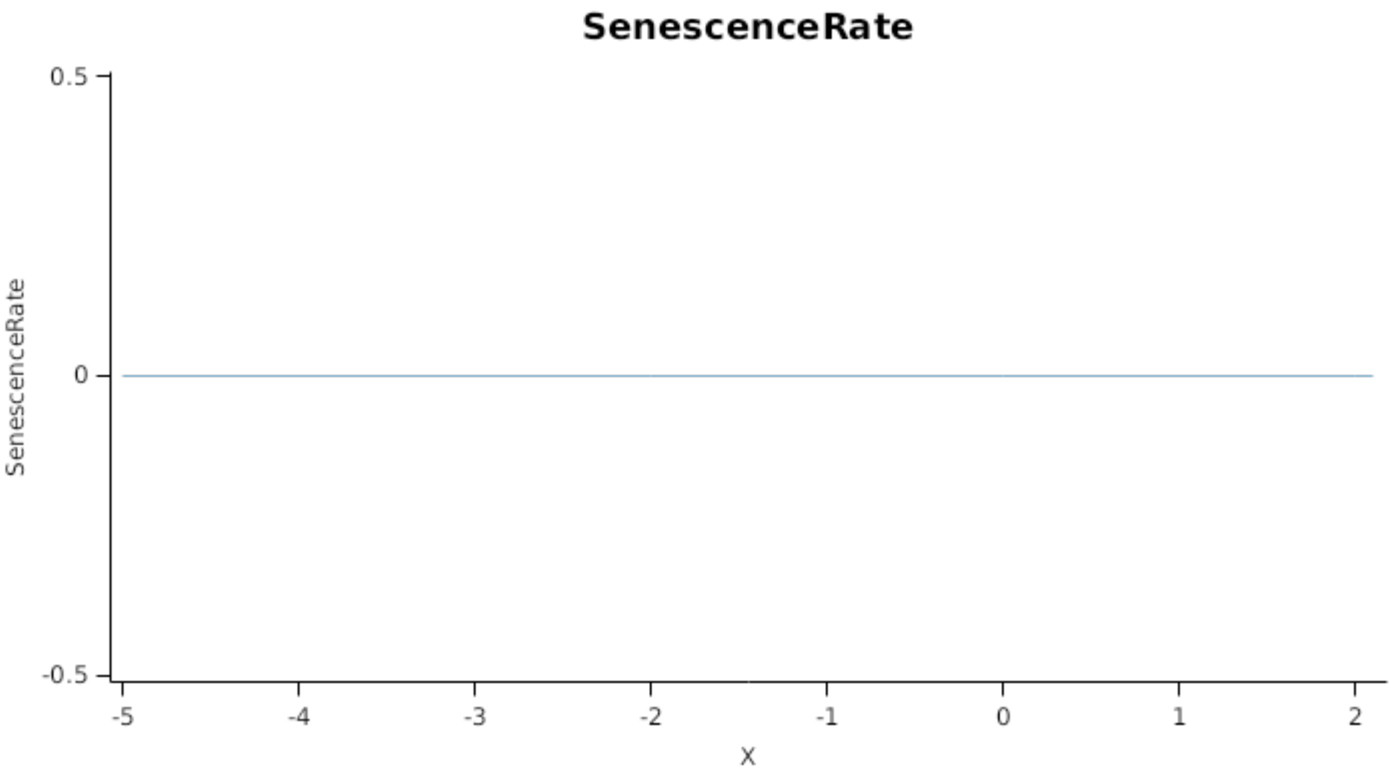
ExtinctionCoefficient = ([ExtinctionCoefficient].KMatureTrees+([ExtinctionCoefficient].KYoungTrees-[ExtinctionCoefficient].KMatureTrees)xExp((0-2)x([Eucalyptus].Leaf.LAI/[ExtinctionCoefficient].LAIIntermediateK)^[ExtinctionCoefficient].ShapeCurve))

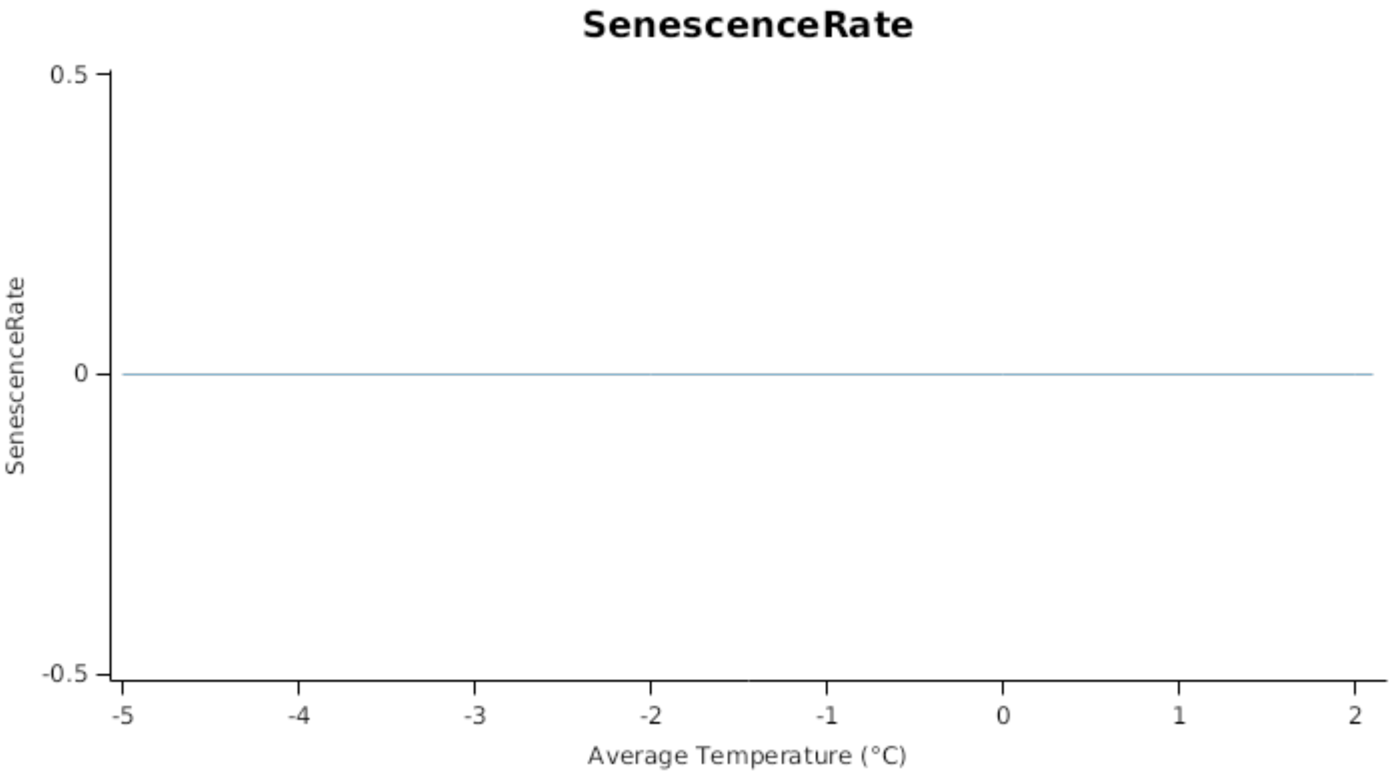
1.16.7 SenescenceRate

SenescenceRate is calculated as a function of daily min and max temperatures, these are weighted toward max temperature according to the specified MaximumTemperatureWeighting factor. A value equal to 1.0 means it will use max temperature, a value of 0.5 means average temperature.

MaximumTemperatureWeighting = 0

X	SenescenceRate
-5.0	0.0
-2.0	0.0
0.0	0.0
2.0	0.0
2.1	0.0





1.16.8 LeafKillFractionFactor

LeafKillFractionFactor = Min(*FT*, *FN*, *FW*)

Where:

FT = [Leaf].Photosynthesis.FT

FN = [Leaf].Photosynthesis.FN

FW = [Leaf].Photosynthesis.FW

1.16.9 LeafKillFraction

LeafKillFraction = 0.0+0x(1-[Leaf].LeafKillFractionFactor)

1.16.10 BiomassRemovalDefaults

This organ will respond to certain management actions by either removing some of its biomass from the system or transferring some of its biomass to the soil surface residues. The following table describes the default proportions of live and dead biomass that are transferred out of the simulation using "Removed" or to soil surface residue using "To Residue" for a range of management actions. The total percentage removed for live or dead must not exceed 100%. The difference between the total and 100% gives the biomass remaining on the plant. These can be changed during a simulation using a manager script.

Method	% Live Removed	% Dead Removed	% Live To Residue	% Dead To Residue
Harvest	100	100	0	0
Cut	80	0	0	0
Prune	0	0	60	0
Thin	100	100	0	0

1.16.11 Photosynthesis

Biomass fixation is modelled as the product of intercepted radiation and its conversion efficiency, the radiation use efficiency (RUE) (Monteith et al., 1977).
This approach simulates net photosynthesis rather than providing separate estimates of growth and respiration.
The potential photosynthesis calculated using RUE is then adjusted according to stress factors, these account for plant nutrition (FN), air temperature (FT), vapour pressure deficit (FVPD), water supply (FW) and atmospheric CO_2 concentration (FCO2).
NOTE: RUE in this model is expressed as g/MJ for a whole plant basis, including both above and below ground growth.

Aboveground RUE for Gliricidia was measured as 1.06 g/MJ by Harrington et al., 1995. Adding c. 0.3 for belowground allocation provides a value of 1.4 g/MJ.

RUE = 1.4 (g/MJ)

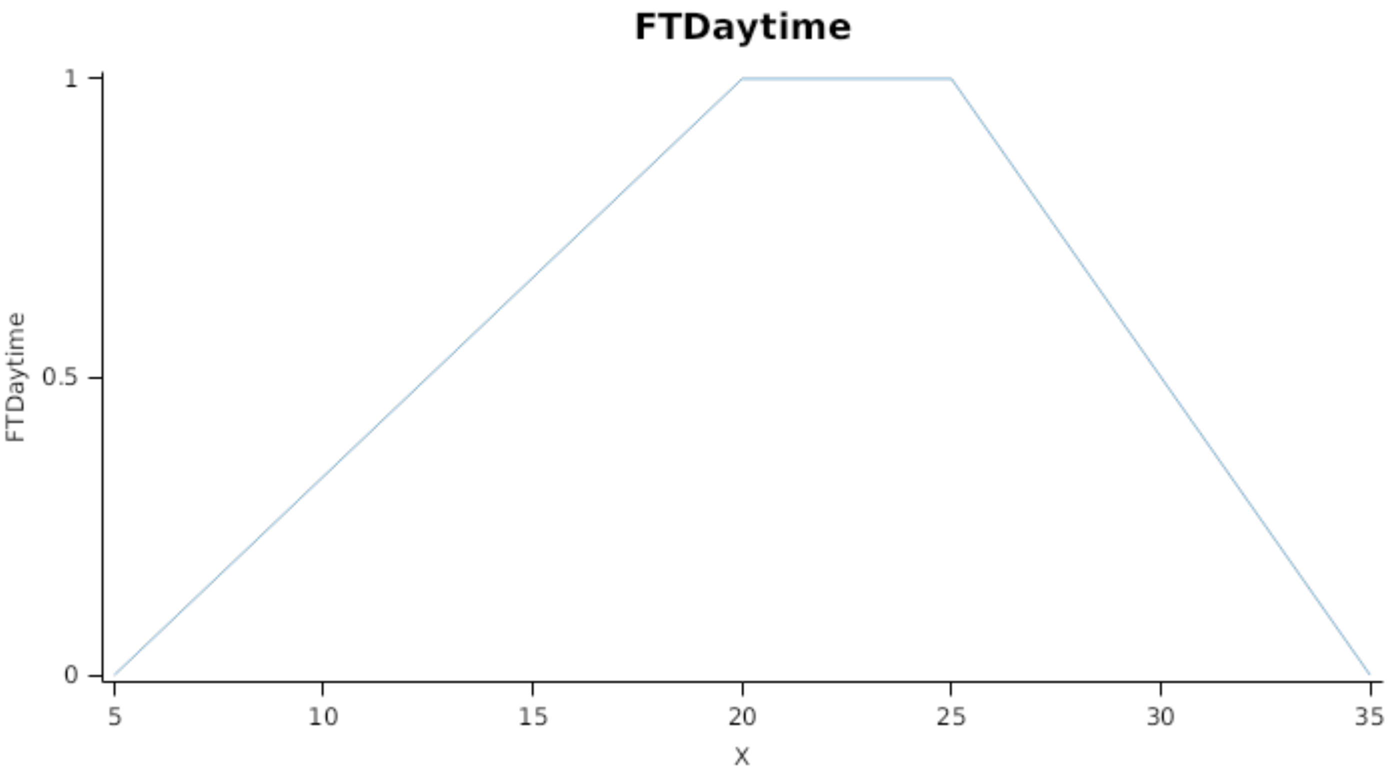
FT = Min(*FTDaytime*, *FTFrost*)

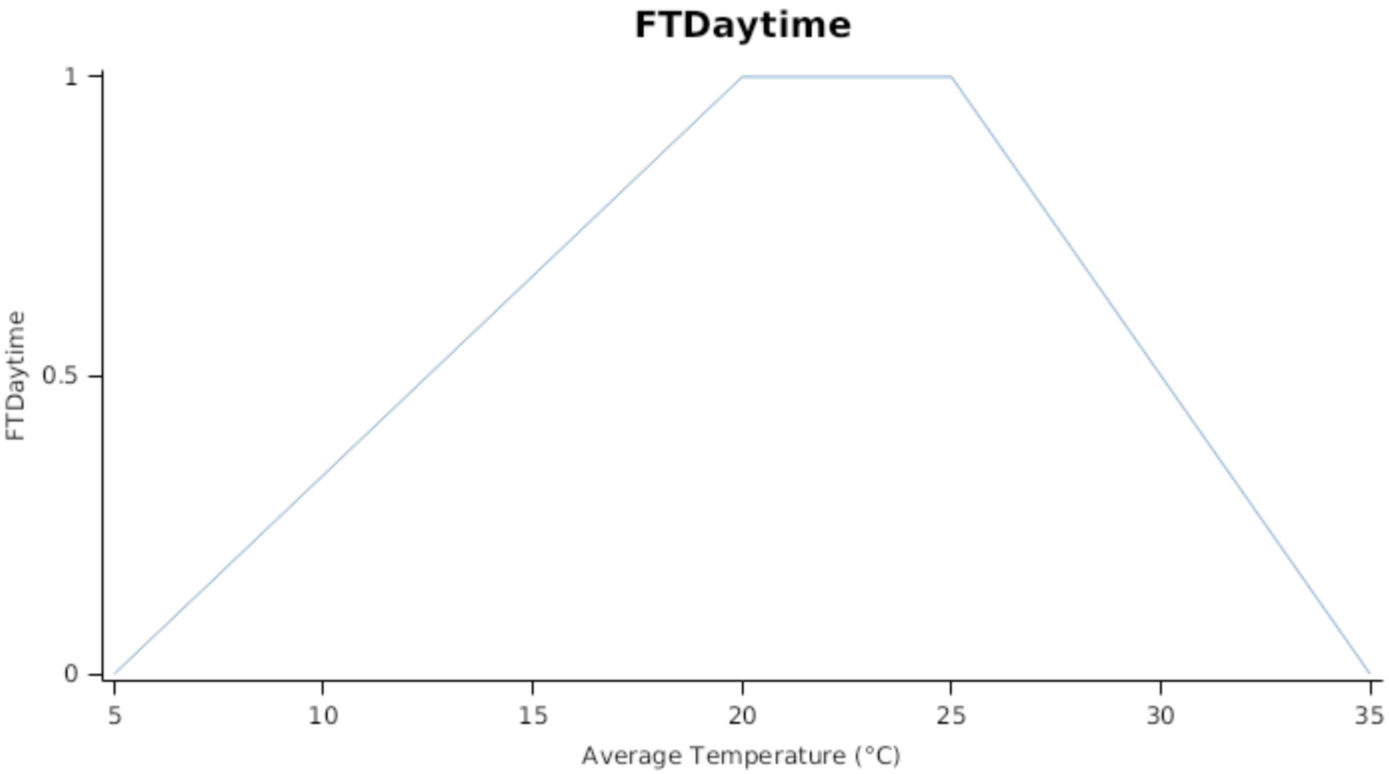
Where:

FTDaytime is calculated as a function of daily min and max temperatures, these are weighted toward max temperature according to the specified MaximumTemperatureWeighting factor. A value equal to 1.0 means it will use max temperature, a value of 0.5 means average temperature.

MaximumTemperatureWeighting = 0.75

X	FTDaytime
5.0	0.0
20.0	1.0
25.0	1.0
35.0	0.0

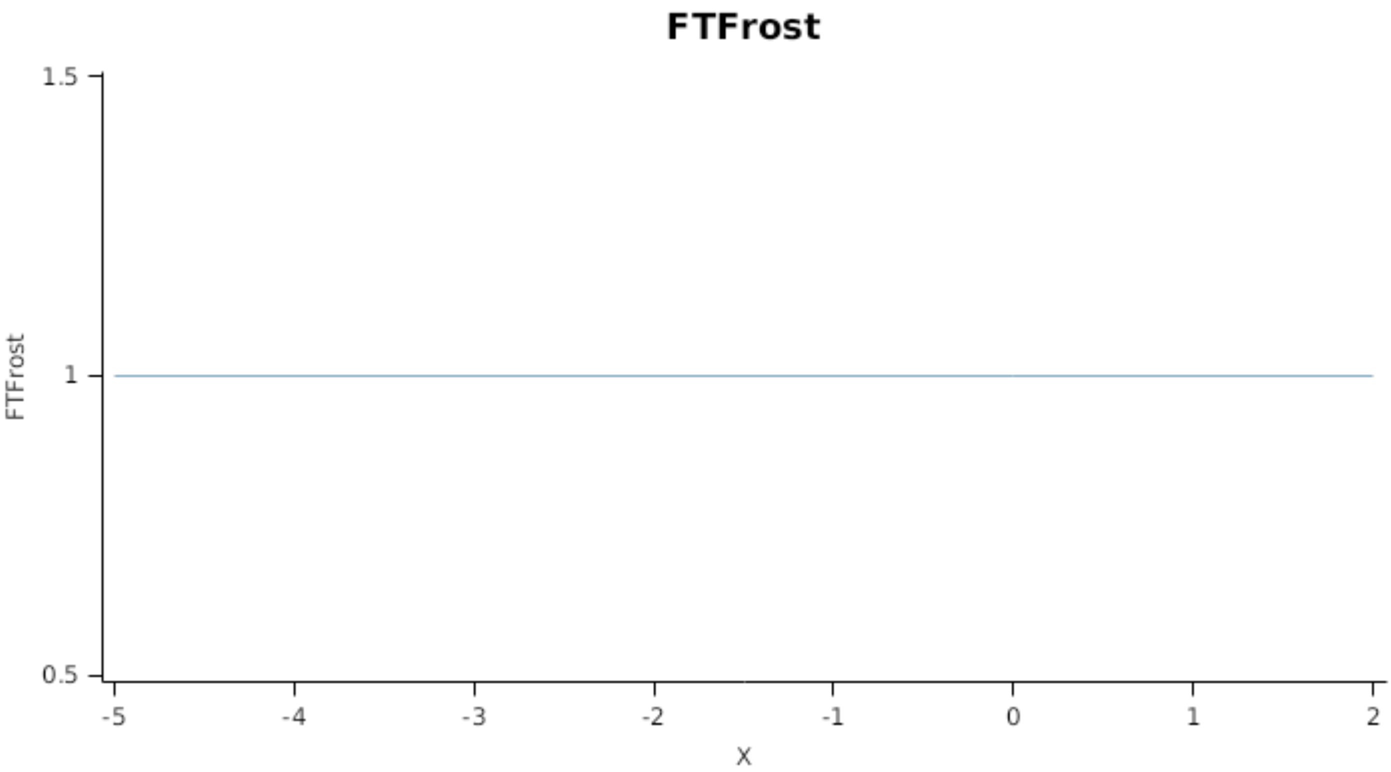


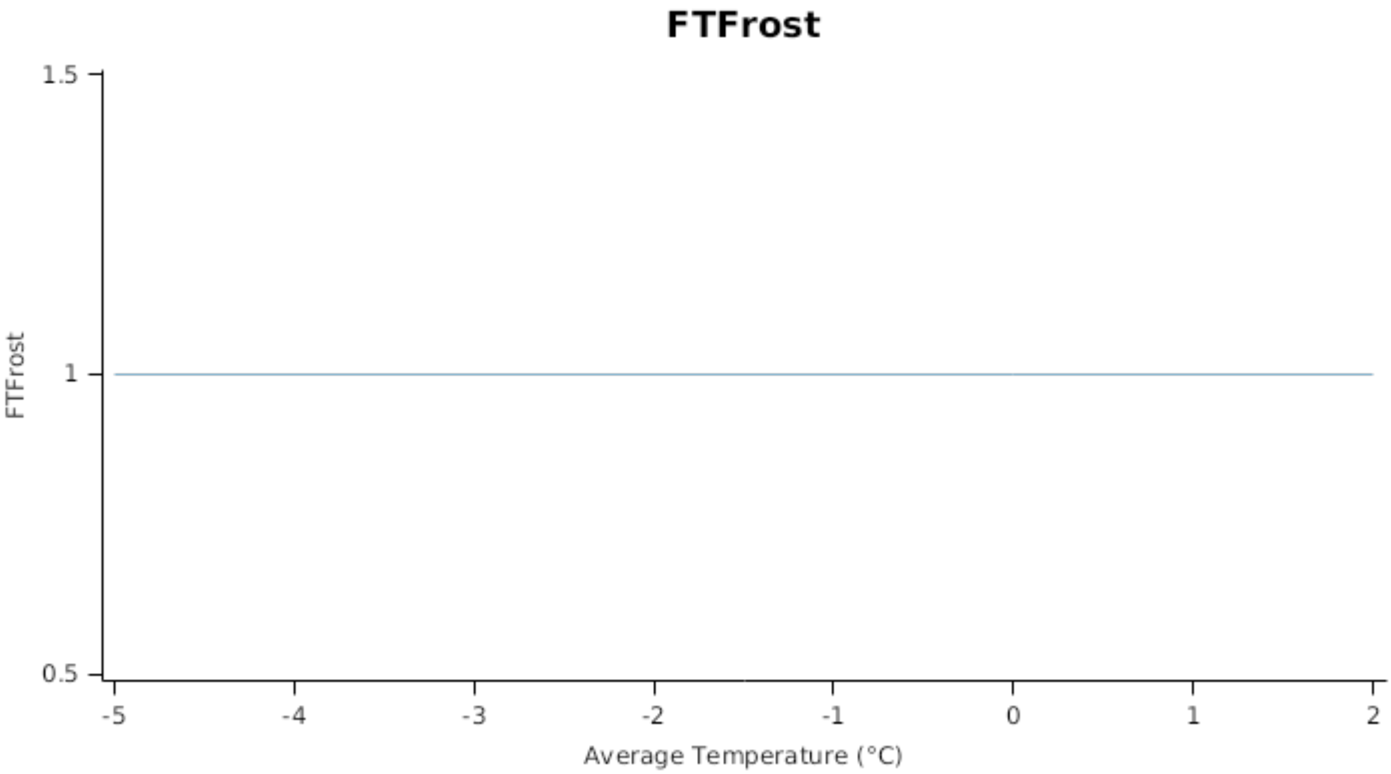


FTFrost is calculated as a function of daily min and max temperatures, these are weighted toward max temperature according to the specified MaximumTemperatureWeighting factor. A value equal to 1.0 means it will use max temperature, a value of 0.5 means average temperature.

MaximumTemperatureWeighting = 0

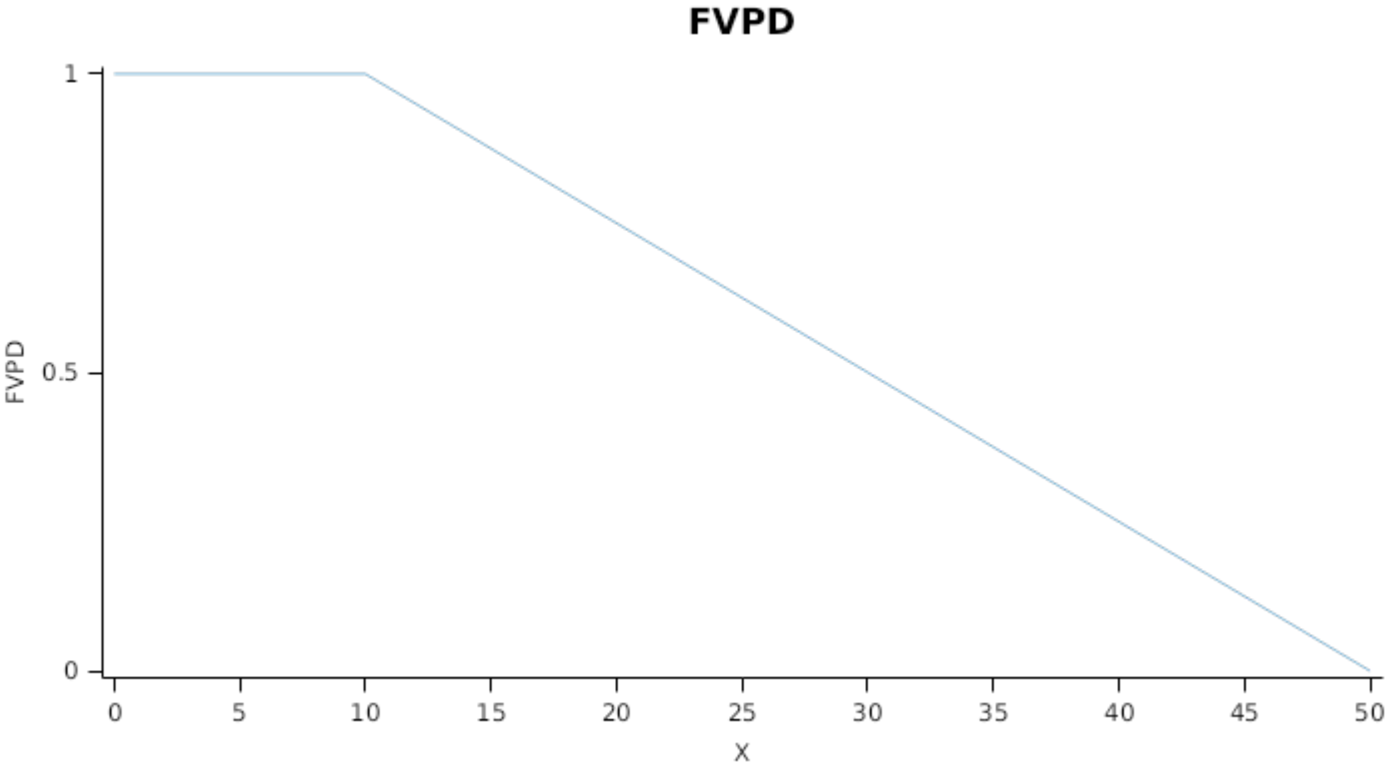
X	FTFrost
-5.0	1.0
0.0	1.0
2.0	1.0





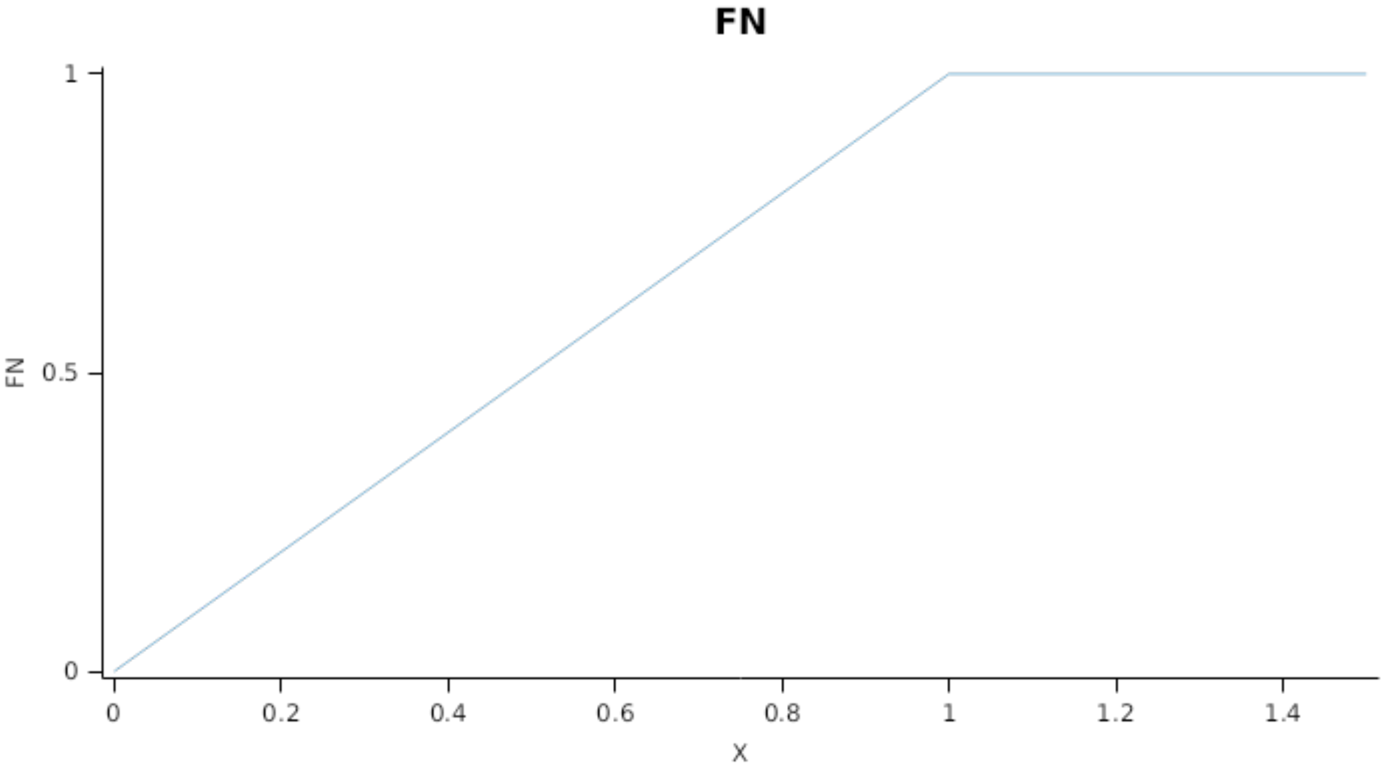
FVPD is calculated using linear interpolation

X	FVPD
0.0	1.0
10.0	1.0
50.0	0.0



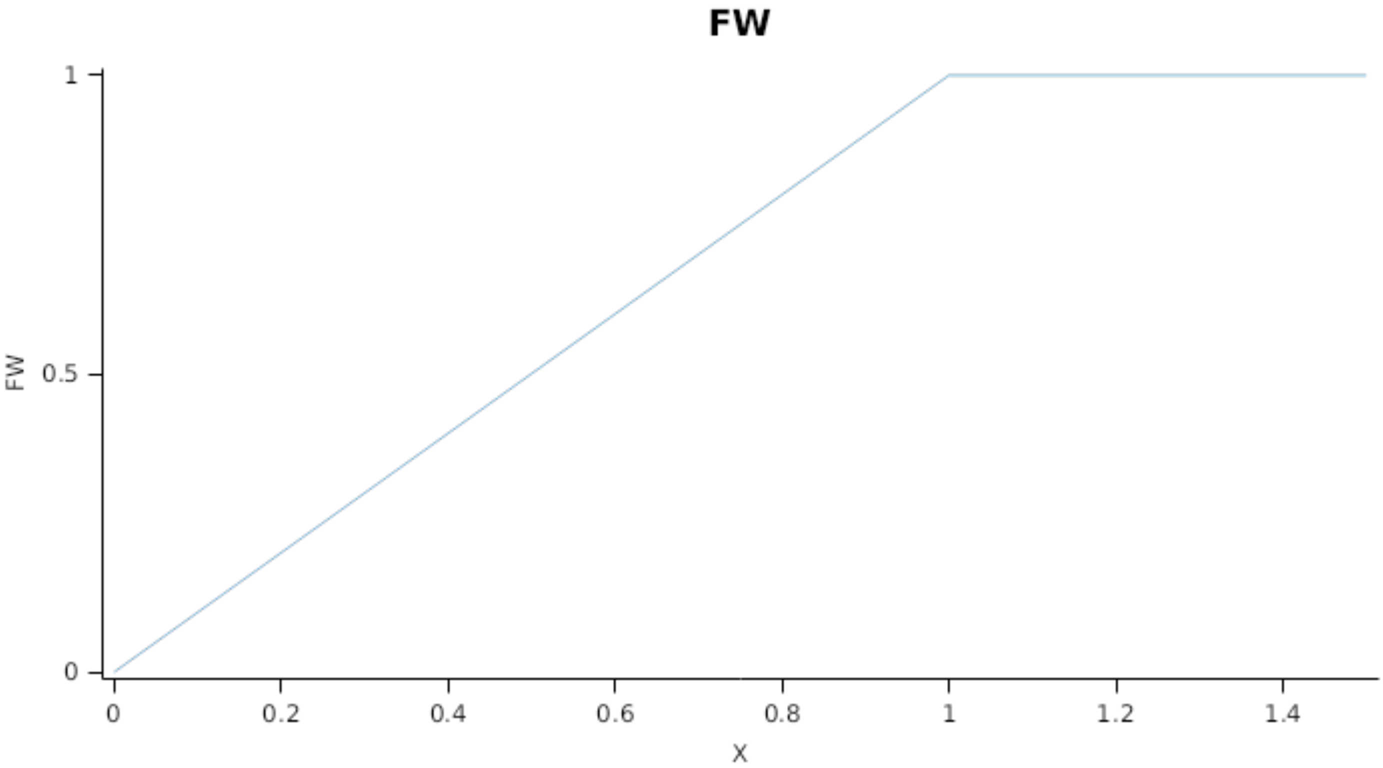
FN is calculated using linear interpolation

X	FN
0.0	0.0
1.0	1.0
1.5	1.0



FW is calculated using linear interpolation

X	FW
0.0	0.0
1.0	1.0
1.5	1.0



This model calculates the CO_2 impact on RUE using the approach of Reyenga et al., 1999.

For C3 plants,

$F_{CO2} = (CO_2 - CP) \times (350 + 2 \times CP)/(CO_2 + 2 \times CP) \times (350 - CP)$

where CP, is the compensation point calculated from daily average temperature (T) as

$CP = (163.0 - T) / (5.0 - 0.1 * T)$

For C4 plants,

$F_{CO2} = 0.000143 * CO_2 + 0.95$

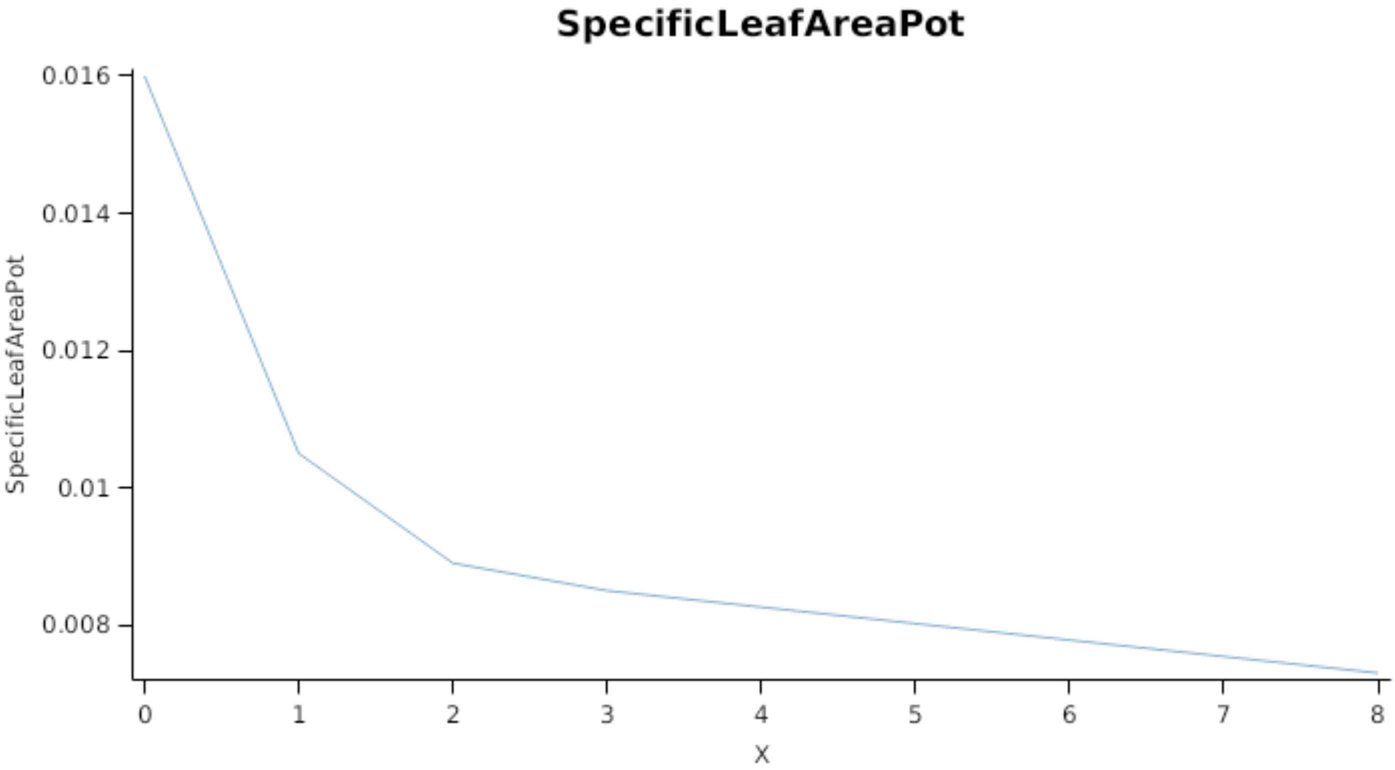
RadnInt = [Leaf].RadiationIntercepted

1.16.12 SpecificLeafAreaFunction

SpecificLeafAreaFunction = *SpecificLeafAreaPot* x *CO2Modifier*

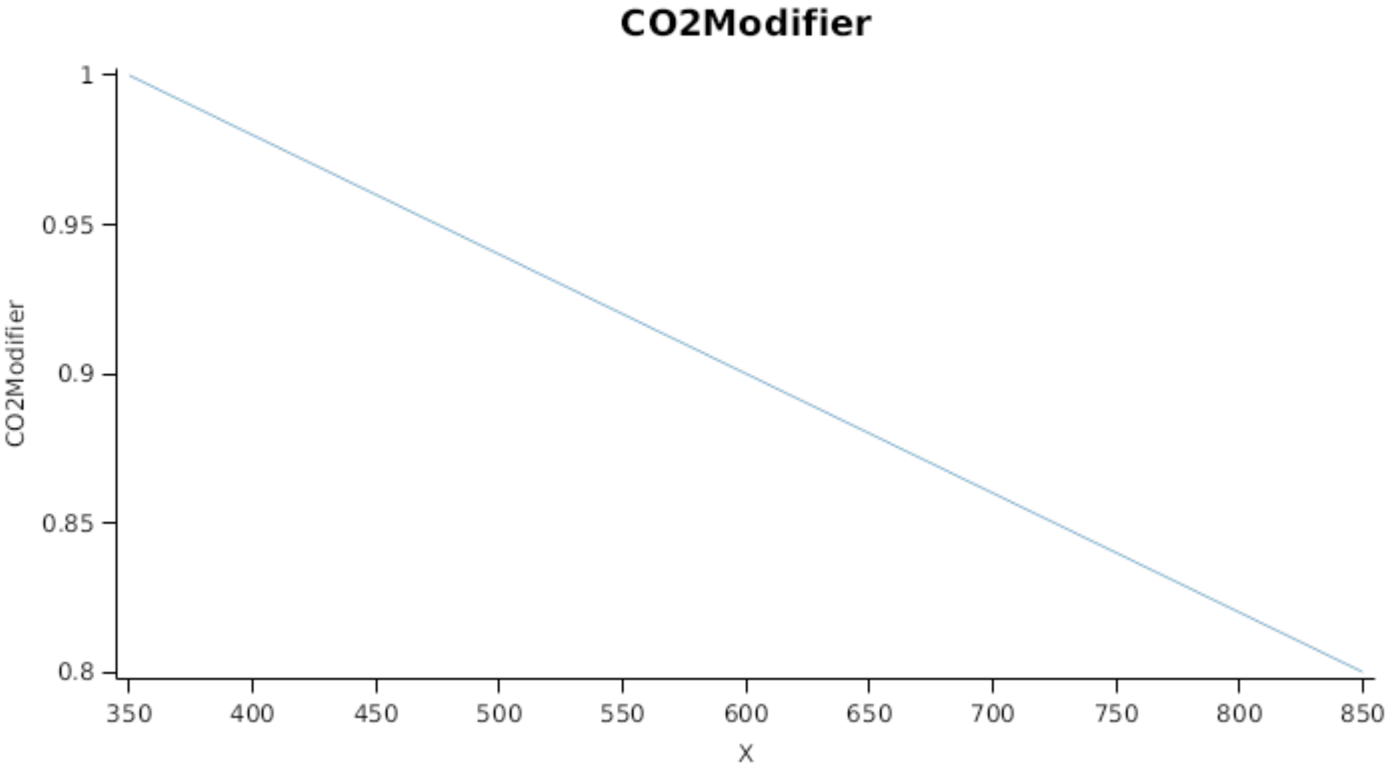
SpecificLeafAreaPot is calculated using linear interpolation

X	SpecificLeafAreaPot
0.0	0.0
1.0	0.0
2.0	0.0
3.0	0.0
8.0	0.0



CO2Modifier is calculated using linear interpolation

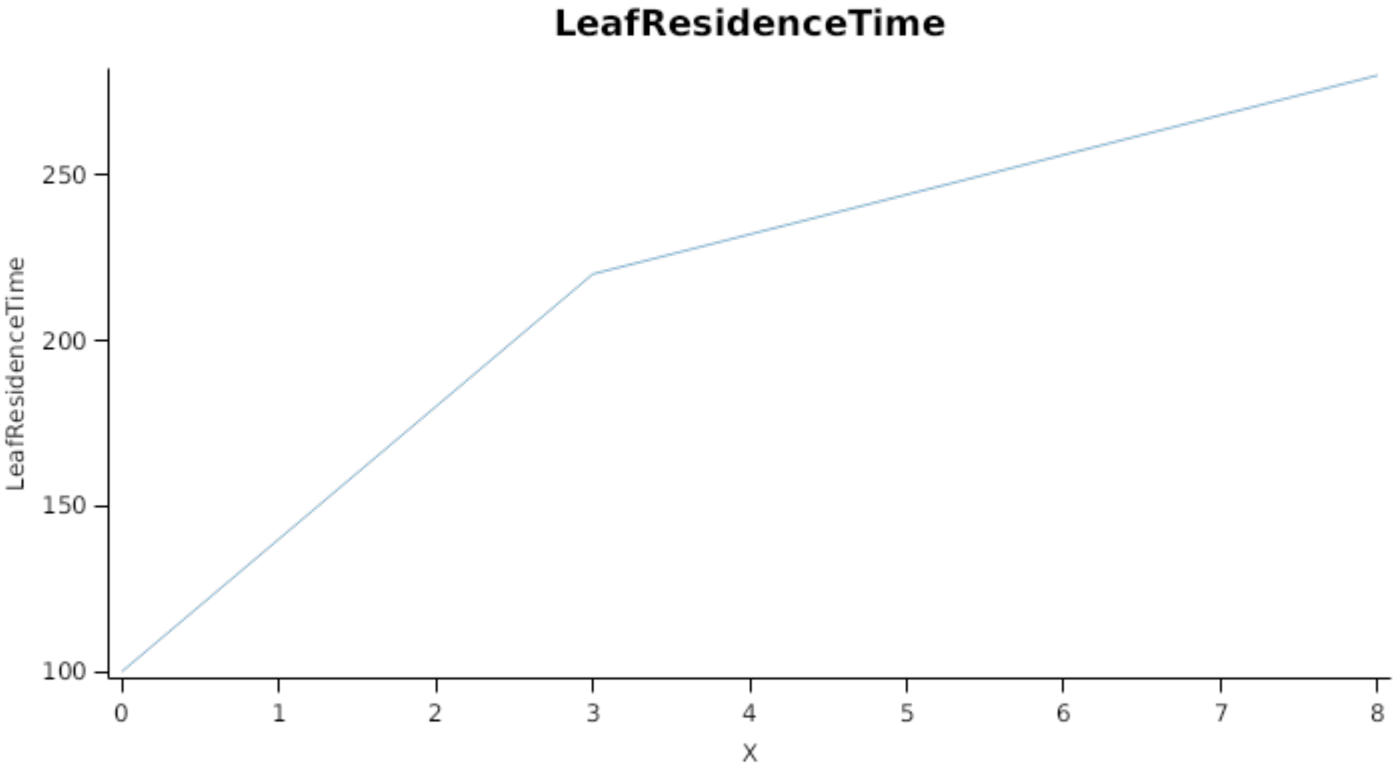
X	CO2Modifier
350.0	1.0
850.0	0.8



1.16.13 LeafResidenceTime

LeafResidenceTime is calculated using linear interpolation

X	LeafResidenceTime
0.0	100.0
1.0	140.0
2.0	180.0
3.0	220.0
8.0	280.0



1.16.14 LeafDevelopmentRate

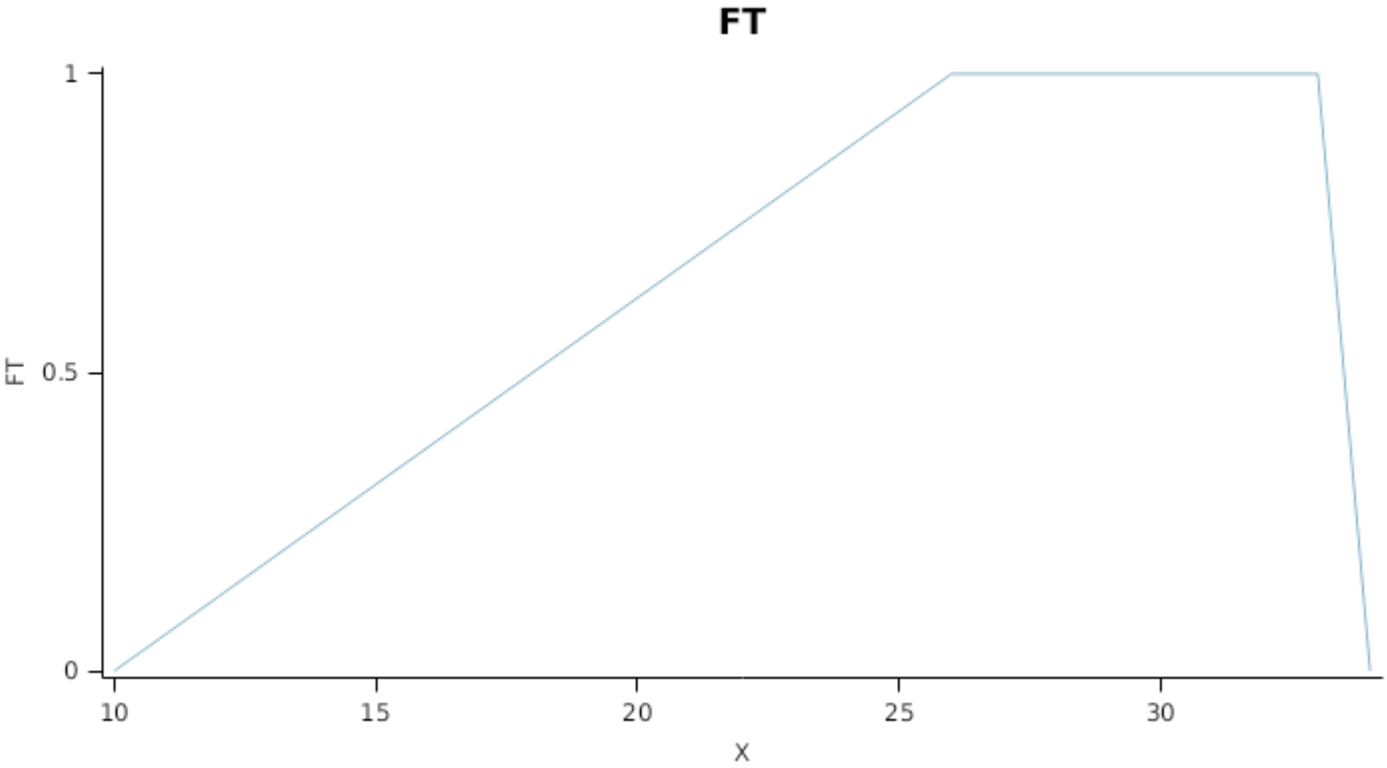
LeafDevelopmentRate = *LDR* x *FT*

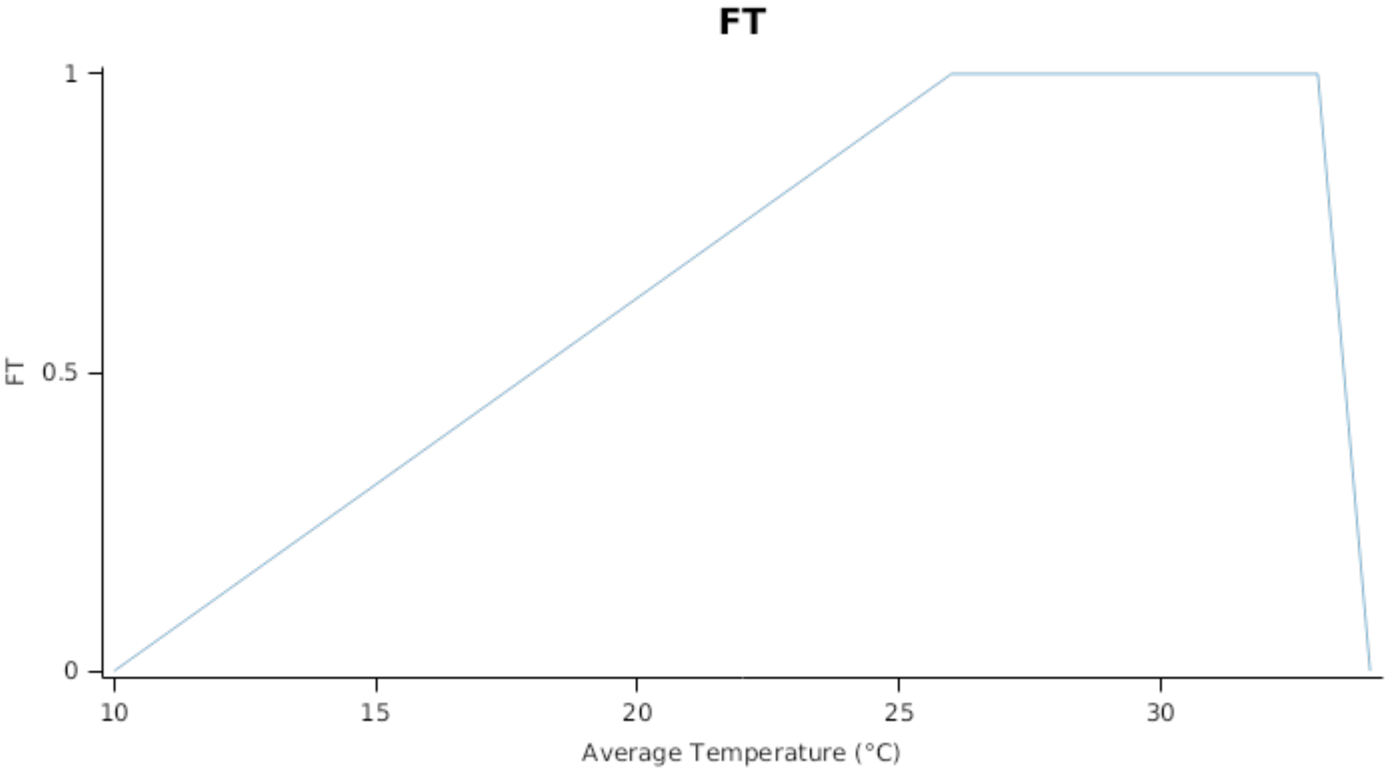
LDR = 1 (0-1)

FT is calculated as a function of daily min and max temperatures, these are weighted toward max temperature according to the specified MaximumTemperatureWeighting factor. A value equal to 1.0 means it will use max temperature, a value of 0.5 means average temperature.

MaximumTemperatureWeighting = 1

X	FT
10.0	0.0
26.0	1.0
33.0	1.0
34.0	0.0





1.16.15 HeightFunction

HeightFunction = [Stem].Htx1000

1.16.16 DMDemands

This class holds the functions for calculating the absolute demands for each biomass fraction.

DM demands are set in a similar ways for each organ, but with different values: structural (default specified), metabolic (value = 0), and storage functions (1 - structural). Values measured range from about 5 to 50% for eucalyptus leaves (Quentin et al., 2015), which also covers the range of 1-20% for other species and plant parts (Hoch et al., 2003). Metabolic demand is set to zero, because RUE is a value for net growth for which a respiration calculation is not needed.

These values may become an important focus if one attempts to use the model for coppicing, as is already the case in several other APSIM models, e.g. lucerne and gliricidia.

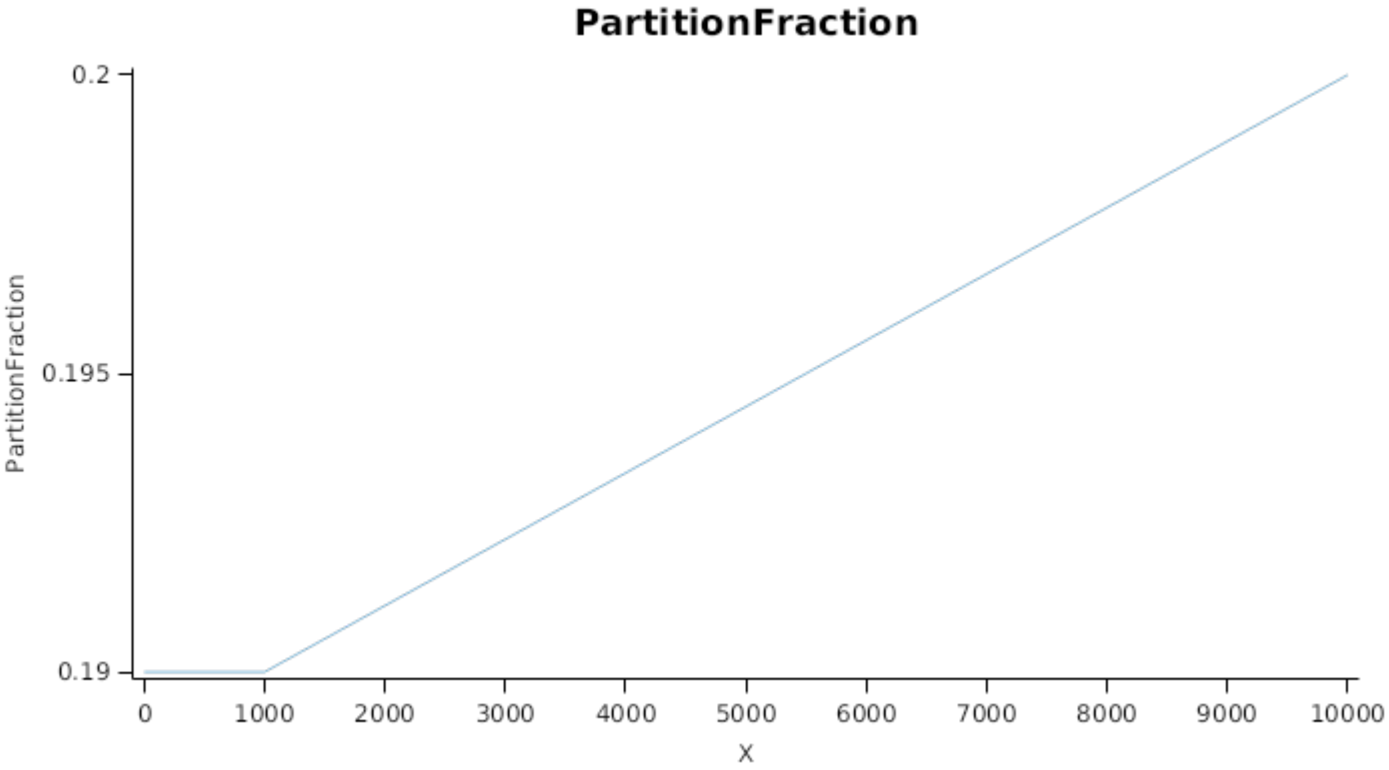
Structural = *DMDemandFunction* x *StructuralFraction*

Returns the product of its PartitionFraction and the total DM supplied to the arbitrator by all organs.

DMDemandFunction = PartitionFraction x [Arbitrator].DM.TotalFixationSupply

PartitionFraction is calculated using linear interpolation

X	PartitionFraction
0.0	0.2
1000.0	0.2
10000.0	0.2



StructuralFraction = 0.99 (0-1)

Metabolic = 0

Storage = 0

1.16.17 NDemands

This class holds the functions for calculating the absolute demands for each biomass fraction.

N demands are set in a similar ways to DM demands, which are described above.

Structural = [Leaf].minimumNconc x [Leaf].potentialDMAllocation.Structural

Metabolic = 0

The partitioning of daily N supply to storage N attempts to bring the organ's N content to the maximum concentration.

Storage = [Leaf].maximumNconc × ([Leaf].Live.Wt + potentialAllocationWt) - [Leaf].Live.N

The demand for storage N is further reduced by a factor specified by the [Leaf].NitrogenDemandSwitch.

MaxNconc = [Leaf].MaximumNconc

NitrogenDemandSwitch = 1

1.17 Branch

1.17.1 Branch

This organ is simulated using a GenericOrgan type. It is parameterised to calculate the growth, senescence, and detachment of any organ that does not have specific functions.

1.17.2 Dry Matter Demand

The dry matter demand for the organ is calculated as defined in DMDemands, based on the DMDemandFunction and partition fractions for each biomass pool.

1.17.2.1 DMDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

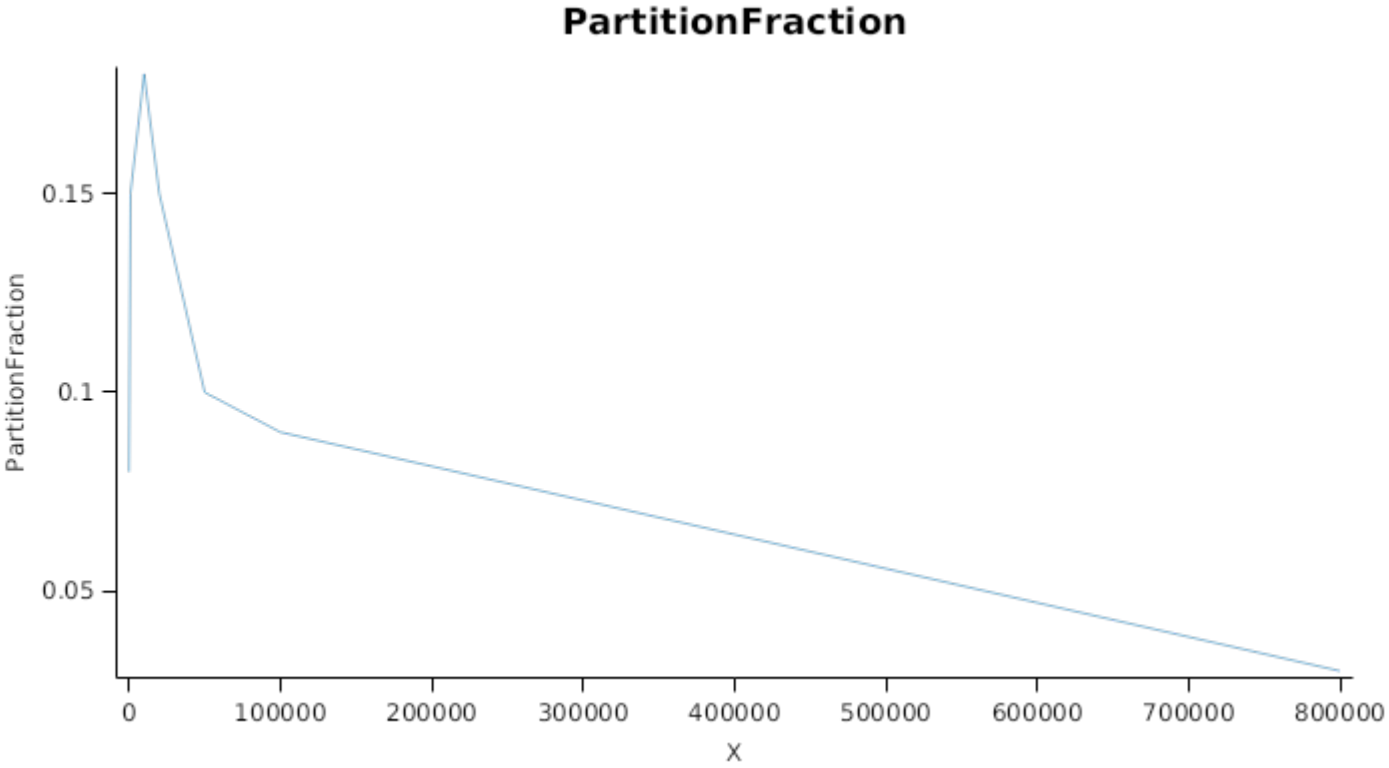
Structural = *DMDemandFunction* x *StructuralFraction*

Returns the product of its PartitionFraction and the total DM supplied to the arbitrator by all organs.

DMDemandFunction = PartitionFraction x [Arbitrator].DM.TotalFixationSupply

PartitionFraction is calculated using linear interpolation

X	PartitionFraction
0.0	0.1
1000.0	0.1
10000.0	0.2
20000.0	0.1
50000.0	0.1
100000.0	0.1
800000.0	0.0



StructuralFraction = 0.99 (0-1)

Metabolic = 0

The partitioning of daily growth to storage biomass is based on a storage fraction.

StorageFraction = 1 - [Branch].DMDemands.Structural.StructuralFraction

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.17.3 Nitrogen Demand

The N demand is calculated as defined in NDemands, based on DM demand the N concentration of each biomass pool.

1.17.3.1 NDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

Structural = [Branch].minimumNconc x [Branch].potentialDMAllocation.Structural

Metabolic = *MetabolicNconc* x [Branch].potentialDMAllocation.Structural

MetabolicNconc = [Branch].criticalNConc - [Branch].minimumNconc

The partitioning of daily N supply to storage N attempts to bring the organ's N content to the maximum concentration.

Storage = [Branch].maximumNconc × ([Branch].Live.Wt + potentialAllocationWt) - [Branch].Live.N

The demand for storage N is further reduced by a factor specified by the [Branch].NitrogenDemandSwitch.

NitrogenDemandSwitch = [Branch].nitrogenDemandSwitch

MaxNconc = [Branch].maximumNconc

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.17.4 N Concentration Thresholds

MinimumNConc = 0.0014 (g/g)

CriticalNConc = [Branch].MinimumNConc

MaximumNConc = 0.01 (g/g)

The demand for N is reduced by a factor specified by the NitrogenDemandSwitch.

NitrogenDemandSwitch has a value between Emergence and Old calculated as:

Constant = 1

1.17.5 Dry Matter Supply

Branch does not reallocate DM when senescence of the organ occurs.

Branch does not retranslocate non-structural DM.

1.17.6 Nitrogen Supply

Branch does not reallocate N when senescence of the organ occurs.

Branch can retranslocate up to 5% of non-structural N each day if required by the plant arbitrator to meet N demands.

1.17.7 Senescence and Detachment

Branch has senescence parameterised to zero so all biomass in this organ will remain alive.

Branch has detachment parameterised to zero so all biomass in this organ will remain with the plant until a defoliation or harvest event occurs.

This organ will respond to certain management actions by either removing some of its biomass from the system or transferring some of its biomass to the soil surface residues. The following table describes the default proportions of live and dead biomass that are transferred out of the simulation using "Removed" or to soil surface residue using "To Residue" for a range of management actions. The total percentage removed for live or dead must not exceed 100%. The difference between the total and 100% gives the biomass remaining on the plant. These can be changed during a simulation using a manager script.

Method	% Live Removed	% Dead Removed	% Live To Residue	% Dead To Residue
Harvest	100	100	0	0
Cut	80	0	0	0
Prune	0	0	60	0
Thin	100	100	0	0

1.18 Stem

1.18.1 Stem

This organ is simulated using a GenericOrgan type. It is parameterised to calculate the growth, senescence, and detachment of any organ that does not have specific functions.

1.18.2 Dry Matter Demand

The dry matter demand for the organ is calculated as defined in DMDemands, based on the DMDemandFunction and partition fractions for each biomass pool.

1.18.2.1 DMDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

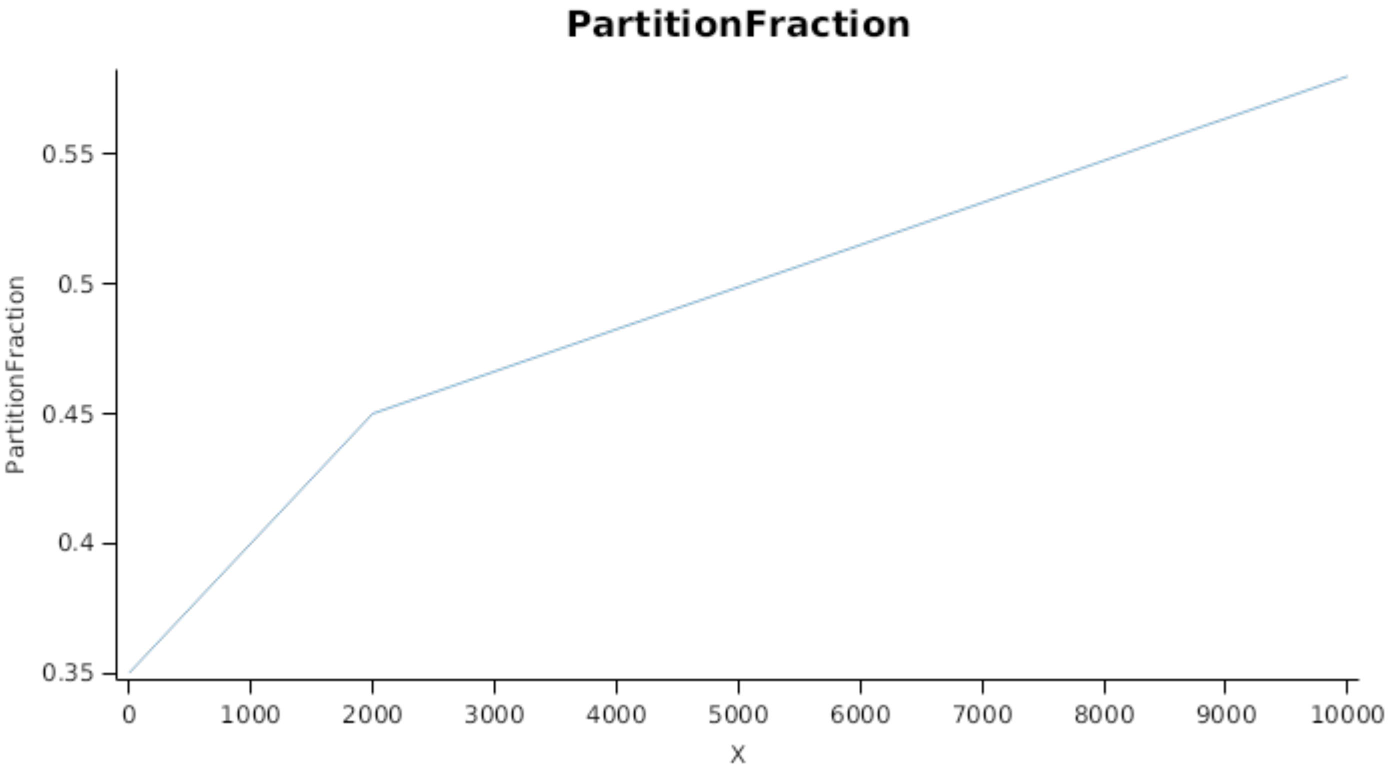
Structural = *DMDemandFunction* x *StructuralFraction*

Returns the product of its PartitionFraction and the total DM supplied to the arbitrator by all organs.

DMDemandFunction = *PartitionFraction* x *[Arbitrator].DM.TotalFixationSupply*

PartitionFraction is calculated using linear interpolation

X	PartitionFraction
0.0	0.3
2000.0	0.5
10000.0	0.6



StructuralFraction = 0.99 (0-1)

Metabolic = 0

The partitioning of daily growth to storage biomass is based on a storage fraction.

StorageFraction = 1 - [Stem].DMDemands.Structural.StructuralFraction

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.18.3 Nitrogen Demand

The N demand is calculated as defined in NDemands, based on DM demand the N concentration of each biomass pool.

1.18.3.1 NDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

Structural = [Stem].minimumNconc x [Stem].potentialDMAllocation.Structural

Metabolic = *MetabolicNconc* x [Stem].potentialDMAllocation.Structural

MetabolicNconc = [Stem].criticalNConc - [Stem].minimumNconc

The partitioning of daily N supply to storage N attempts to bring the organ's N content to the maximum concentration.

Storage = [Stem].maximumNconc × ([Stem].Live.Wt + potentialAllocationWt) - [Stem].Live.N

The demand for storage N is further reduced by a factor specified by the [Stem].NitrogenDemandSwitch.

NitrogenDemandSwitch = [Stem].nitrogenDemandSwitch

MaxNconc = [Stem].maximumNconc

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.18.4 N Concentration Thresholds

MinimumNConc = 0.0014 (g/g)

CriticalNConc = [Stem].MinimumNConc

Branch, stem and coarse root minimum N concentrations are based on Raymond et al., 2000.

MaximumNConc = 0.01 (g/g)

The demand for N is reduced by a factor specified by the NitrogenDemandSwitch.

NitrogenDemandSwitch has a value between Emergence and Old calculated as:

Constant = 1

1.18.5 Dry Matter Supply

Stem does not reallocate DM when senescence of the organ occurs.

Stem does not retranslocate non-structural DM.

1.18.6 Nitrogen Supply

Stem does not reallocate N when senescence of the organ occurs.

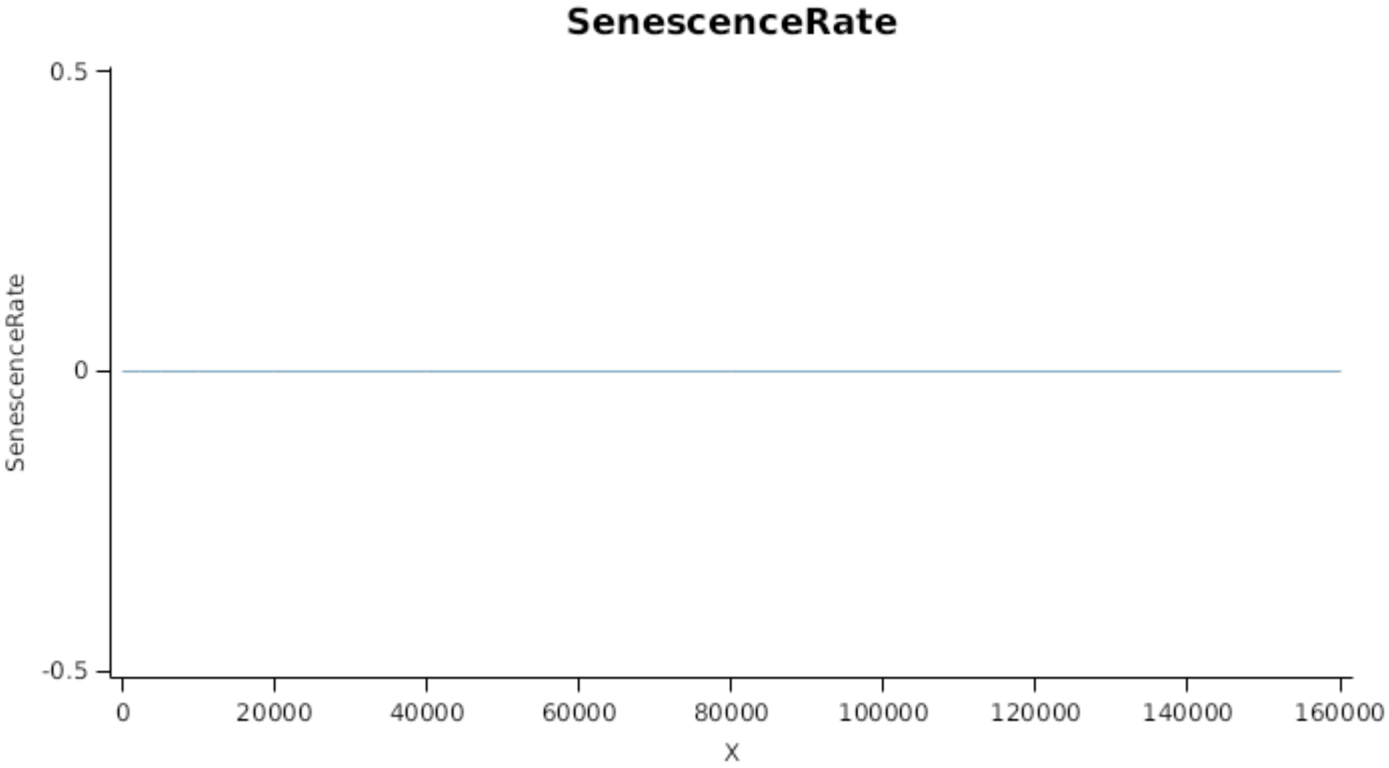
Stem can retranslocate up to 5% of non-structural N each day if required by the plant arbitrator to meet N demands.

1.18.7 Senescence and Detachment

The proportion of live biomass that senesces and moves into the dead pool each day is quantified by the SenescenceRate.

SenescenceRate is calculated using linear interpolation

X	SenescenceRate
0.0	0.0
2500.0	0.0
5000.0	0.0
10000.0	0.0
20000.0	0.0
40000.0	0.0
80000.0	0.0
160000.0	0.0



Stem has detachment parameterised to zero so all biomass in this organ will remain with the plant until a defoliation or harvest event occurs.

This organ will respond to certain management actions by either removing some of its biomass from the system or transferring some of its biomass to the soil surface residues. The following table describes the default proportions of live and dead biomass that are transferred out of the simulation using "Removed" or to soil surface residue using "To Residue" for a range of management actions. The total percentage removed for live or dead must not exceed 100%. The difference between the total and 100% gives the biomass remaining on the plant. These can be changed during a simulation using a manager script.

Method	% Live Removed	% Dead Removed	% Live To Residue	% Dead To Residue
Harvest	100	100	0	0
Cut	80	0	0	0
Prune	0	0	60	0
Thin	100	100	0	0

1.19 CoarseRoot

1.19.1 CoarseRoot

This organ is simulated using a GenericOrgan type. It is parameterised to calculate the growth, senescence, and detachment of any organ that does not have specific functions.

1.19.2 Dry Matter Demand

The dry matter demand for the organ is calculated as defined in DMDemands, based on the DMDemandFunction and partition fractions for each biomass pool.

1.19.2.1 DMDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

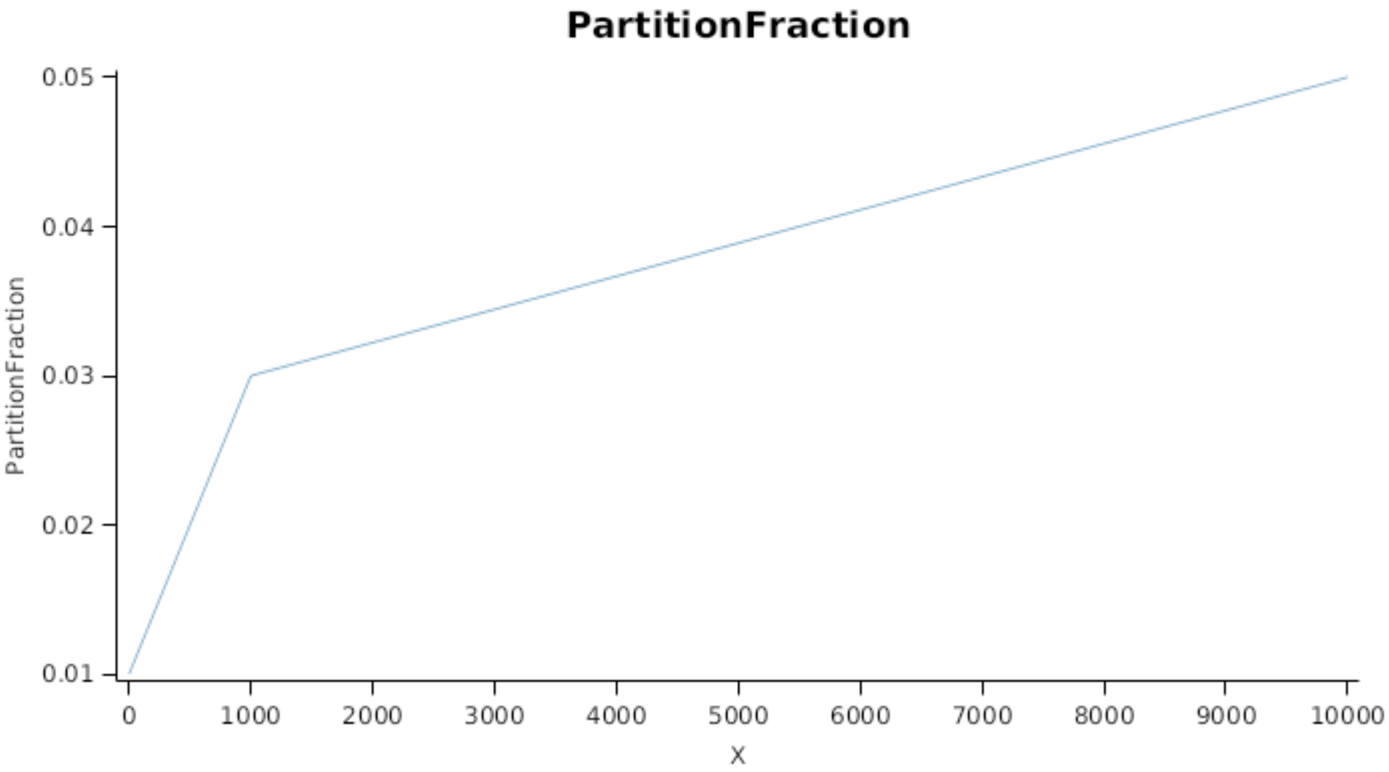
Structural = *DMDemandFunction* x *StructuralFraction*

Returns the product of its PartitionFraction and the total DM supplied to the arbitrator by all organs.

DMDemandFunction = *PartitionFraction* x *[Arbitrator].DM.TotalFixationSupply*

PartitionFraction is calculated using linear interpolation

X	PartitionFraction
0.0	0.0
1000.0	0.0
10000.0	0.1



StructuralFraction = 0.99 (0-1)

Metabolic = 0

The partitioning of daily growth to storage biomass is based on a storage fraction.

StorageFraction = 1 - [CoarseRoot].DMDemands.Structural.StructuralFraction

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.19.3 Nitrogen Demand

The N demand is calculated as defined in NDemands, based on DM demand the N concentration of each biomass pool.

1.19.3.1 NDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

Structural = [CoarseRoot].minimumNconc x [CoarseRoot].potentialDMAllocation.Structural

Metabolic = *MetabolicNconc* x [CoarseRoot].potentialDMAllocation.Structural

MetabolicNconc = [CoarseRoot].criticalNConc - [CoarseRoot].minimumNconc

The partitioning of daily N supply to storage N attempts to bring the organ's N content to the maximum concentration.

Storage = [CoarseRoot].maximumNconc × ([CoarseRoot].Live.Wt + potentialAllocationWt) - [CoarseRoot].Live.N

The demand for storage N is further reduced by a factor specified by the [CoarseRoot].NitrogenDemandSwitch.

NitrogenDemandSwitch = [CoarseRoot].nitrogenDemandSwitch

MaxNconc = [CoarseRoot].maximumNconc

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.19.4 N Concentration Thresholds

MinimumNConc = 0.0014 (g/g)

CriticalNConc = [Stem].MinimumNConc

MaximumNConc = 0.01 (g/g)

The demand for N is reduced by a factor specified by the NitrogenDemandSwitch.

NitrogenDemandSwitch has a value between Emergence and Old calculated as:

Constant = 1

1.19.5 Dry Matter Supply

CoarseRoot does not reallocate DM when senescence of the organ occurs.

CoarseRoot does not retranslocate non-structural DM.

1.19.6 Nitrogen Supply

CoarseRoot does not reallocate N when senescence of the organ occurs.

CoarseRoot can retranslocate up to 5% of non-structural N each day if required by the plant arbitrator to meet N demands.

1.19.7 Senescence and Detachment

CoarseRoot has senescence parameterised to zero so all biomass in this organ will remain alive.

CoarseRoot has detachment parameterised to zero so all biomass in this organ will remain with the plant until a defoliation or harvest event occurs.

This organ will respond to certain management actions by either removing some of its biomass from the system or transferring some of its biomass to the soil surface residues. The following table describes the default proportions of live and dead biomass that are transferred out of the simulation using "Removed" or to soil surface residue using "To Residue" for a range of management actions. The total percentage removed for live or dead must not exceed 100%. The difference between the total and 100% gives the biomass remaining on the plant. These can be changed during a simulation using a manager script.

Method	% Live Removed	% Dead Removed	% Live To Residue	% Dead To Residue
Harvest	0	0	100	100
Cut	80	0	0	0
Prune	0	0	60	0
Thin	0	0	5	0

1.20 FineRoot

The root model calculates root growth in terms of rooting depth, biomass accumulation and subsequent root length density in each soil layer.

1.20.1 Growth

Roots grow downwards through the soil profile, with initial depth determined by sowing depth and the growth rate determined by RootFrontVelocity. The RootFrontVelocity is modified by multiplying it by the soil's XF value, which represents any resistance posed by the soil to root extension.

$\text{Root Depth Increase} = \text{RootFrontVelocity} \text{ x } XF_i \text{ x } \text{RootDepthStressFactor}$

where i is the index of the soil layer at the rooting front.

Root depth is also constrained by a maximum root depth.

Root length growth is calculated using the daily DM partitioned to roots and a specific root length. Root proliferation in layers is calculated using an approach similar to the generalised equimarginal criterion used in economics. The uptake of water and N per unit root length is used to partition new root material into layers of higher 'return on investment'. For example, the Root Activity for water is calculated as

$RAw_i = -\text{WaterUptake}_i / \text{LiveRootWt}_i \text{ x } \text{LayerThickness}_i \text{ x } \text{ProportionThroughLayer}$

The amount of root mass partitioned to a layer is then proportional to root activity

$\text{DMAllocated}_i = \text{TotalDMAllocated} \text{ x } RAw_i / \text{TotalRAw}$

1.20.2 Dry Matter Demands

A daily DM demand is provided to the organ arbitrator and a DM supply returned. By default, 100% of the dry matter (DM) demanded from the root is structural. The daily loss of roots is calculated using a SenescenceRate function. All senesced material is automatically detached and added to the soil FOM.

1.20.3 Nitrogen Demands

The daily structural N demand from root is the product of total DM demand and the minimum N concentration. Any N above this is considered Storage and can be used for retranslocation and/or reallocation as the respective factors are set to values other then zero.

1.20.4 Nitrogen Uptake

Potential N uptake by the root system is calculated for each soil layer (i) that the roots have extended into. In each layer potential uptake is calculated as the product of the mineral nitrogen in the layer, a factor controlling the rate of extraction (kNO3 or kNH4), the concentration of N form (ppm), and a soil moisture factor (NUptakeSWFactor) which typically decreases as the soil dries. $\text{NO3 uptake} = NO3_i \text{ x } kNO3 \text{ x } NO3_{ppm,\, i} \text{ x } \text{NUptakeSWFactor}$ _NH4 uptake = $NH4_i$ x kNH4 x $NH4_{ppm,\, i}$ x NUptakeSWFactor_As can be seen from the above equations, the values of kNO3 and kNH4 equate to the potential fraction of each mineral N pool which can be taken up per day for wet soil when that pool has a concentration of 1 ppm.Nitrogen uptake demand is limited to the maximum daily potential uptake (MaxDailyNUptake) and the plant's N demand. The former provides a means to constrain N uptake to a maximum value observed in the field for the crop as a whole.The demand for soil N is then passed to the soil arbitrator which determines how much of the N uptake demandeach plant instance will be allowed to take up.

1.20.5 Water Uptake

Potential water uptake by the root system is calculated for each soil layer that the roots have extended into. In each layer potential uptake is calculated as the product of the available water in the layer (water above LL limit) and a factor controlling the rate of extraction (KL). The values of both LL and KL are set in the soil interface and KL may be further modified by the crop via the KLModifier function. $\text{SW uptake} = (SW_i - LL_i) \text{ x } KL_i \text{ x } \text{KLModifier}$

1.20.6 Constants

Huth et al., 2008 measured a constant root front velocity of 24.3 mm/d down to 1.4 m depth under favourable growing conditions, which was similar to wheat. de Moraes Goncalves et al., 2013 report eucalypt root front velocities averaging 19 mm/day for the first 1.5 years to 12 mm/day by 3.5 years in conditions of little impedence to root growth. The value of 10 mm/d used here is lower to reflect more common limiting conditions.

RootFrontVelocity = 10 (mm/d)

SenescenceRate = 0.005 (/d)

MaxDailyNUptake = 6 (kg/ha/d)

Fine root N concentrations are based on Misra et al (1998).

MaximumNConc = 0.01 (g/g)

MinimumNConc = 0.003 (g/g)

MaximumRootDepth = 10000 (mm)

KLModifier = 1

KNO3 = 0.03

KNH4 = 3E-06

Specific root length was based on Jourdan et al., 2008.

SpecificRootLength = 40 (m/g)

DMConversionEfficiency = 1 (0-1)

MaintenanceRespirationFunction = 0 (0-1)

RemobilisationCost = 0

CarbonConcentration = 0.45 (g/g)

RootDepthStressFactor = 1

1.20.7 RootShape

This model calculates the proportion of each soil layer occupied by roots.

1.20.8 Memo

For many of the parameters in this organ, see comments for similar parameters in the leaf organ.

1.20.9 NitrogenDemandSwitch

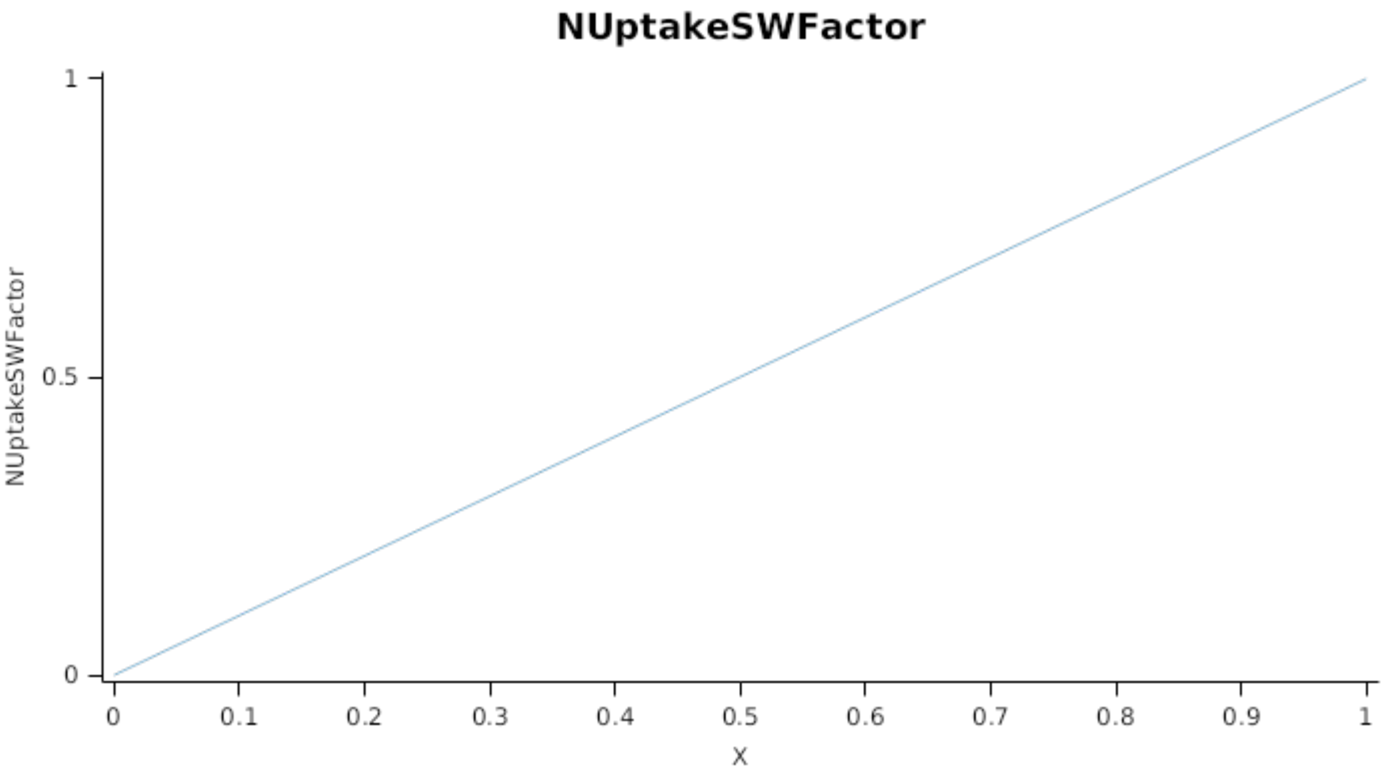
NitrogenDemandSwitch has a value between Emergence and Old calculated as:

Constant = 1

1.20.10 NUptakeSWFactor

NUptakeSWFactor is calculated using linear interpolation

X	NUptakeSWFactor
0.0	0.0
1.0	1.0



1.20.11 BiomassRemovalDefaults

This organ will respond to certain management actions by either removing some of its biomass from the system or transferring some of its biomass to the soil surface residues. The following table describes the default proportions of live and dead biomass that are transferred out of the simulation using "Removed" or to soil surface residue using "To Residue" for a range of management actions. The total percentage removed for live or dead must not exceed 100%. The difference between the total and 100% gives the biomass remaining on the plant. These can be changed during a simulation using a manager script.

Method	% Live Removed	% Dead Removed	% Live To Residue	% Dead To Residue
Harvest	0	0	100	100
Cut	80	0	0	0
Prune	0	0	60	0

1.20.12 DMDemands

1.20.12.1 DMDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

Structural = *DMDemandFunction* x *StructuralFraction*

Returns the product of its PartitionFraction and the total DM supplied to the arbitrator by all organs.

DMDemandFunction = PartitionFraction x [Arbitrator].DM.TotalFixationSupply

PartitionFraction = 0.25

StructuralFraction = 1

Metabolic = 0

The partitioning of daily growth to storage biomass is based on a storage fraction.

StorageFraction = 1 - [FineRoot].DMDemands.Structural.StructuralFraction

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.20.13 NDemands

1.20.13.1 NDemands

This class holds the functions for calculating the absolute demands and priorities for each biomass fraction.

DM or N demands here are set in a similar way to those described above for the leaf organ.

Structural = [FineRoot].minimumNconc x [FineRoot].potentialDMAllocation.Structural

Metabolic = *MetabolicNconc* x [FineRoot].potentialDMAllocation.Structural

MetabolicNconc = [FineRoot].criticalNConc - [FineRoot].minimumNconc

The partitioning of daily N supply to storage N attempts to bring the organ's N content to the maximum concentration.

Storage = [FineRoot].maximumNconc × ([FineRoot].Live.Wt + potentialAllocationWt) - [FineRoot].Live.N

The demand for storage N is further reduced by a factor specified by the [FineRoot].NitrogenDemandSwitch.

NitrogenDemandSwitch = [FineRoot].nitrogenDemandSwitch

MaxNconc = [FineRoot].maximumNconc

QStructuralPriority = 1

QMetabolicPriority = 1

QStoragePriority = 1

1.20.14 CriticalNConc

CriticalNConc = [FineRoot].MinimumNConc

1.20.15 InitialWt

This class holds the functions for calculating the absolute demands for each biomass fraction.

Structural = 0.2 (g/plant)

Metabolic = 0

Storage = 0

1.21 RootShootRatio

RootShootRatio = [Eucalyptus].BelowGround.Wt / [Eucalyptus].AboveGround.Wt

1.22 grandis

1.22.1 grandis

grandis overrides the following properties:

1.22.2 grandisCoffsHarbour

grandisCoffsHarbour overrides the following properties:

[Branch].SenescenceRate.FixedValue=0.0002

1.22.3 grandisC15

grandisC15 overrides the following properties:

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0,0.03,0.04

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.24,0.2,0.2,.23,0.2,.12

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.06,.06,.06,.05,.04,.03

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.2

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.2,0.45,0.7,0.99,0.99,.99

[Stem].DBH.DBHEquation.Expression=0.36*[Eucalyptus].IndividualTreeStemWt^0.34-5.2

1.22.4 grandisC22

grandisC22 overrides the following properties:

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0,0.08,0.08

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.22,0.2,0.19,0.13,0.10,.06

1.23 grandisXurophylla

1.23.1 grandisXurophylla

grandisXurophylla overrides the following properties:

1.23.2 grandisXurophyllaC3334

grandisXurophyllaC3334 overrides the following properties:

1.23.3 grandisXurophyllaC3336

grandisXurophyllaC3336 overrides the following properties:

1.24 urophyllaXglobulus

1.24.1 urophyllaXglobulus

urophyllaXglobulus overrides the following properties:

1.25 BrazilClones

1.25.1 BrazilPlasticClone

BrazilPlasticClone overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.51

[Leaf].ExtinctionCoefficient.KYoungTrees.FixedValue = 0.34

[Leaf].ExtinctionCoefficient.KMatureTrees.FixedValue = 0.60

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.15, 0.39, 0.61

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.09,0.09,0.09

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y= 0.2, 0.17, 0.15

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X= 8, 18, 23, 40

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y 0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X= -5, -2, -1, 0, 1, 2, 2.1

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y = 0, 0, 0, 0, 0, 0.9, 1

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.7, 0.5, 0.2, 0.1, 0

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.005,0.03,0.04

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue = 0.26

1.25.2 BrazilTropicalClone

BrazilTropicalClone overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.69

[Leaf].ExtinctionCoefficient.KYoungTrees.FixedValue = 0.30

[Leaf].ExtinctionCoefficient.KMatureTrees.FixedValue = 0.56

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.15,0.40, 0.64

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.08,0.08,0.08

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y= 0.19, 0.17, 0.17

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X= 8, 18, 23, 40

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y 0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X= -5, -2, -1, 0, 1, 2, 2.1

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y = 0, 0, 0, 0, 0, 0.9, 1

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.7, 0.5, 0.2, 0.1, 0

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.03,0.1,0.1

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue = 0.35

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 80

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.018, 0.014, 0.011, 0.009, 0.008, 0.007

1.25.3 BrazilSubTropicalClone

BrazilSubTropicalClone overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.57

[Leaf].ExtinctionCoefficient.KYoungTrees.FixedValue = 0.26

[Leaf].ExtinctionCoefficient.KMatureTrees.FixedValue = 0.55

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.15, 0.30, 0.57

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.09,0.09,0.09

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y= 0.20, 0.16, 0.15

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X= 6, 17, 22, 38

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y 0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X= -5, -2, -1, 0, 1, 2, 2.1

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y = 0.5, 1, 1, 1, 1, 1, 1

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.7, 0.5, 0.2, 0.1, 0

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,2000,10000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.02,0.05,0.06

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue = 0.24

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 80

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.015, 0.013, 0.009, 0.008, 0.007, 0.007

1.26 saligna

1.26.1 saligna

saligna overrides the following properties:

1.27 nitens

1.27.1 nitens

nitens overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.58

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X= 2,13,24,32

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y= 0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.MaximumTemperatureWeighting=0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X=-5, -2, -1, 0, 1, 2, 3, 4, 7

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y= 0, 0, 0, 0, .1, .2, .6,.8, 1

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=2,23,32,33

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=600, 800, 900, 1095, 1095

[Leaf].LeafKillFraction.Expression=0.0+0.001*(1-[Leaf].LeafKillFractionFactor)

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 5, 5.1

[Leaf].SenescenceRate.XYPairs.Y = 0.2,0, 0, 0, 0

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.006, 0.0059, 0.0057, 0.0055, 0.0055, 0.0055, 0.0055, 0.0055

[Leaf].MaximumNConc.FixedValue=0.026

[Leaf].MinimumNConc.FixedValue=0.009

[Branch].MaximumNConc.FixedValue=0.01

[Branch].MinimumNConc.FixedValue=0.003

[Stem].MaximumNConc.FixedValue=0.004

[Stem].MinimumNConc.FixedValue=0.0015

[CoarseRoot].MaximumNConc.FixedValue=0.004

[CoarseRoot].MinimumNConc.FixedValue=0.0015

[FineRoot].MaximumNConc.FixedValue=0.026

[FineRoot].MinimumNConc.FixedValue=0.009

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XValue.VariableName=[Eucalyptus].AboveGround.Wt

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,80,800,1600,4000,6400, 8000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.35,0.32,0.22,.2,.13,.1, 0.08

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.15,.22,.22,.18,.13,.12

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.05,0.15,0.4,0.94,0.97,.98, .99,.999

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,500,1000,5000, 10000, 20000, 40000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.35,0.33, 0.31, 0.3, 0.25, .2, .18

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.06

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.X=0, 2000, 10000, 20000, 100000

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.Y=0.5, 0.7, 0.88, 0.9, 0.98

[Stem].SenescenceRate.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].SenescenceRate.XYPairs.Y=0, 0, 0, 0, 0, 0, 0.01, 0.02

[FineRoot].SenescenceRate.FixedValue=0.00005

[Stem].DBH.DBHEquation.Expression=0.445*[Eucalyptus].IndividualTreeStemWt^0.335-2.0

[Stem].Ht.HeightFunction.Expression=0.43*[Eucalyptus].IndividualTreeStemWt^0.34-2.5

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 25

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.08, .1, .15, .2, .5, .8, 1.2, 1.9

[Stem].Volub.Expression=[Eucalyptus].Stem.Vol-[Eucalyptus].Stem.VolBark*0.6

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(0.945*(([Eucalyptus].Stem.Ht-1.4)^-1.161)+0.325)

1.27.2 nitensLewisham

nitensLewisham overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.7

[Leaf].FRGRFunction.FRGRFunctionTemp.Response.X=6, 21, 22, 30

[Leaf].FRGRFunction.FRGRFunctionTemp.Response.Y=0,1,1,0

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X= 2,13,14,32

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y= 0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.MaximumTemperatureWeighting=0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X=-5, -2, -1, 0, 1, 2, 3, 4, 7

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y= 0, 0, 0, 0, 0, 0, .5,.8, 1

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=4,23,32,33

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=150, 200, 190, 210, 240

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.006, 0.0059, 0.0057, 0.0055, 0.0055, 0.0055, 0.0055, 0.0055

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.3, 0.2, 0.1, .08, .0

[Leaf].MaximumNConc.FixedValue=0.03

[Leaf].MinimumNConc.FixedValue=0.018

[Branch].MaximumNConc.FixedValue=0.01

[Branch].MinimumNConc.FixedValue=0.003

[Stem].MaximumNConc.FixedValue=0.004

[Stem].MinimumNConc.FixedValue=0.0015

[CoarseRoot].MaximumNConc.FixedValue=0.004

[CoarseRoot].MinimumNConc.FixedValue=0.0015

[FineRoot].MaximumNConc.FixedValue=0.03

[FineRoot].MinimumNConc.FixedValue=0.018

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000, 100000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.3,0.3,0.19,.18,.03,.02, 0.01

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.13,.2,.2,.15,.11,.10

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.05,0.2,0.4,0.6,0.8,.7, .6,.37

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,500,1000,5000, 10000, 20000, 40000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.11,0.1, 0.09, 0.09, 0.09, .09, .09

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.23

[Stem].SenescenceRate.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].SenescenceRate.XYPairs.Y=0, 0, 0, 0, 0, 0, 0.01, 0.02

[FineRoot].SenescenceRate.FixedValue=0.001

[Stem].DBH.DBHEquation.Expression=0.445*[Eucalyptus].IndividualTreeStemWt^0.335-2.0

[Stem].Ht.HeightFunction.Expression=0.43*[Eucalyptus].IndividualTreeStemWt^0.334-2.5

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 25

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.2, .25, .3, .4, .6, .8, 1.2, 1.9

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(0.947*(([Eucalyptus].Stem.Ht-1.4)^-1.161)+0.83)

1.28 globulus

1.28.1 globulus

globulus overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.34

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X=3, 14, 28, 35

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y=0, 1, 1, 0

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.01, 0.008, 0.006, 0.005, 0.0035, 0.0033, 0.0033, 0.0033

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=8,25,33,34

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=600, 800, 900, 1095, 1095

[Leaf].LeafKillFraction.Expression=0.0+0.001*(1-[Leaf].LeafKillFractionFactor)

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.6, 0.4, 0.1, .0, .0

[Leaf].MaximumNConc.FixedValue=0.026

[Leaf].MinimumNConc.FixedValue=0.009

[Branch].MaximumNConc.FixedValue=0.01

[Branch].MinimumNConc.FixedValue=0.003

[Stem].MaximumNConc.FixedValue=0.004

[Stem].MinimumNConc.FixedValue=0.0015

[CoarseRoot].MaximumNConc.FixedValue=0.004

[CoarseRoot].MinimumNConc.FixedValue=0.0015

[FineRoot].MaximumNConc.FixedValue=0.026

[FineRoot].MinimumNConc.FixedValue=0.009

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XValue.VariableName=[Eucalyptus].AboveGround.Wt

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,80,800,1600,4000,6400, 8000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.30,0.25,0.15,.15,.15,.15, 0.14

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.15,.22,.22,.18,.13,.12

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.05,0.13,0.35,0.8,0.97,.98, .99,.999

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,500,1000,5000, 10000, 20000, 40000, 50000, 100000, 200000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.37,0.35, 0.33, 0.32, 0.3, .25, .2, .15, .12, .1

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.06

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.X=0, 2000, 10000, 20000, 100000

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.Y=0.7, 0.8, 0.95, 0.98, 0.99

[Stem].SenescenceRate.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].SenescenceRate.XYPairs.Y=0, 0, 0, 0, 0, 0, 0.01, 0.02

[FineRoot].SenescenceRate.FixedValue=0.00005

[Stem].DBH.DBHEquation.Expression=0.445*[Eucalyptus].IndividualTreeStemWt^0.32-1.0

[Stem].Ht.HeightFunction.Expression=8.507*LN([Eucalyptus].Age)+2.6617

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population*1.3

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(1*(([Eucalyptus].Stem.Ht-1.4)^-1.161)+0.34)

[Stem].Volub.Expression=[Eucalyptus].Stem.Vol-[Eucalyptus].Stem.VolBark*0.9

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 20

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.2, .25, .28, .3, .4, .5, .6, .7

1.28.2 globulusShepparton

globulusShepparton overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.55

[Photosynthesis].FT.FTDaytime.XYPairs.X=3, 14, 28, 35

[Photosynthesis].FT.FTDaytime.XYPairs.Y=0, 1, 1, 0

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.01, 0.008, 0.006, 0.005, 0.0035, 0.0033, 0.0033, 0.0033

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=8,25,33,34

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=150, 170, 190, 230, 270

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.8, 0.4, 0.1, .08, .0

[Leaf].MaximumNConc.FixedValue=0.035

[Leaf].MinimumNConc.FixedValue=0.018

[Branch].MaximumNConc.FixedValue=0.013

[Branch].MinimumNConc.FixedValue=0.0035

[Stem].MaximumNConc.FixedValue=0.0075

[Stem].MinimumNConc.FixedValue=0.0025

[CoarseRoot].MaximumNConc.FixedValue=0.02

[CoarseRoot].MinimumNConc.FixedValue=0.0025

[FineRoot].MaximumNConc.FixedValue=0.02

[FineRoot].MinimumNConc.FixedValue=0.005

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0, 1000,

10000, 25000, 50000, 100000, 200000, 400000, 800000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y= 0.2, 0.15, 0.11, 0.07, 0.05, 0.03, 0.02, 0.015, 0.015

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0, 1000,

10000, 25000, 50000, 100000, 200000, 400000, 800000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y= 0.15, 0.2, 0.2, 0.18, 0.12, 0.08, 0.06, 0.04, 0.03

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,

1000,

10000, 25000, 50000, 100000, 200000, 400000, 800000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.1, 0.2, 0.4, 0.7, 0.8, 0.9, 0.95, 0.99, 0.99

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,

1000,

10000, 25000, 50000, 100000, 200000, 400000, 800000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.5, 0.4,

0.3, 0.25, 0.22, 0.22, 0.2, 0.2, 0.19

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.11

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.X=0, 2000, 10000, 20000, 100000

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.Y=0.7, 0.8, 0.82, 0.85, 0.89

[Stem].SenescenceRate.XYPairs.X=0,2500,5000,10000,20000,40000,80000,16000

[Stem].SenescenceRate.XYPairs.Y=0.00003,0.00003,0.00005,0.00005,0.00005,0.00005,0.01,0.02

[Stem].DetachmentRateFunction.FixedValue=0.05

[Stem].DBH.DBHEquation.Expression=0.445*[Eucalyptus].IndividualTreeStemWt^0.32-1.0

[Stem].Ht.HeightFunction.Expression=8.507*LN([Eucalyptus].Age)+2.6617

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population*1.3

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(1*(([Eucalyptus].Stem.Ht-1.4)^-1.161)+0.34)

[Stem].Volub.Expression=[Eucalyptus].Stem.Vol-[Eucalyptus].Stem.VolBark*0.9

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 20

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.2, .25, .28, .3, .4, .5, .6, .7

1.28.3 WABlueGum

WABlueGum overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.34

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X=3, 14, 28, 35

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y=0, 1, 1, 0

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.X=-5, -2, -1, 0, 1, 2, 3, 4, 7

[Leaf].Photosynthesis.FT.FTFrost.XYPairs.Y= 0, 0, 0, 0, .1, .2, .6,.8, 1

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.007, 0.005, 0.004, 0.0035, 0.003, 0.0029, 0.0028, 0.0033

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=8,25,33,34

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=500, 700, 800, 900, 900

[Leaf].LeafKillFraction.Expression=0.0+0.001*(1-[Leaf].LeafKillFractionFactor)

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 2, 2.1

[Leaf].SenescenceRate.XYPairs.Y = 0.6, 0.4, 0.1, .0, .0

[Leaf].MaximumNConc.FixedValue=0.026

[Leaf].MinimumNConc.FixedValue=0.009

[Branch].MaximumNConc.FixedValue=0.01

[Branch].MinimumNConc.FixedValue=0.003

[Stem].MaximumNConc.FixedValue=0.004

[Stem].MinimumNConc.FixedValue=0.0015

[CoarseRoot].MaximumNConc.FixedValue=0.004

[CoarseRoot].MinimumNConc.FixedValue=0.0015

[FineRoot].MaximumNConc.FixedValue=0.026

[FineRoot].MinimumNConc.FixedValue=0.009

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XValue.VariableName=[Eucalyptus] .AboveGround.Wt

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,80,800,1600,4000,6400, 8000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.30,0.25,0.15,.15,.15,.15, 0.14

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.15,.22,.22,.18,.13,.12

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.05,0.13,0.35,0.8,0.97,.98, .99,.999

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,500,1000,5000, 10000, 20000, 40000, 50000, 100000, 200000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.37,0.35, 0.33, 0.32, 0.3, .25, .2, .15, .12, .1

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.06

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.X=0, 2000, 10000, 20000, 100000

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.Y=0.7, 0.8, 0.95, 0.98, 0.99

[Stem].SenescenceRate.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].SenescenceRate.XYPairs.Y=0, 0, 0, 0, 0, 0, 0.01, 0.02

[FineRoot].SenescenceRate.FixedValue=0.00005

[Stem].DBH.DBHEquation.Expression=0.2*[Eucalyptus].IndividualTreeStemWt^0.37+2.5

[Stem].Ht.HeightFunction.Expression=8.3*LN([Eucalyptus].Age)+0.6617

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population*1.3

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(0.947*(([Eucalyptus].Stem.Ht-1.4)^ -1.161)+0.317)

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 25

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.1, .15, .2, .3, .6, .8, 1.2, 1.9

[Stem].Volub.Expression=([Eucalyptus].Stem.Vol-[Eucalyptus].Stem.VolBark)*0.9

1.28.4 FSABlueGum

FSABlueGum overrides the following properties:

[Leaf].Photosynthesis.RUE.FixedValue = 1.34

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.X=3, 14, 28, 35

[Leaf].Photosynthesis.FT.FTDaytime.XYPairs.Y=0, 1, 1, 0

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.X= 0, 1, 2, 3, 4, 5, 6, 12

[Leaf].SpecificLeafAreaFunction.SpecificLeafAreaPot.XYPairs.Y= 0.01, 0.008, 0.006, 0.005, 0.0035, 0.0033, 0.0033, 0.0033

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=8,25,33,34

[Leaf].LeafDevelopmentRate.FT.XYPairs.X=0,1,1,0

[Leaf].LeafResidenceTime.XYPairs.X=0,1,2,3,8

[Leaf].LeafResidenceTime.XYPairs.Y=600, 800, 900, 1095, 1095

[Leaf].LeafKillFraction.Expression=0.0+0.001*(1-[Leaf].LeafKillFractionFactor)

[Leaf].SenescenceRate.XYPairs.X= -5, -2, 0, 5, 5.1

[Leaf].SenescenceRate.XYPairs.Y = 0.6, 0.4, 0.1, .0, .0

[Leaf].MaximumNConc.FixedValue=0.026

[Leaf].MinimumNConc.FixedValue=0.009

[Branch].MaximumNConc.FixedValue=0.01

[Branch].MinimumNConc.FixedValue=0.003

[Stem].MaximumNConc.FixedValue=0.004

[Stem].MinimumNConc.FixedValue=0.0015

[CoarseRoot].MaximumNConc.FixedValue=0.004

[CoarseRoot].MinimumNConc.FixedValue=0.0015

[FineRoot].MaximumNConc.FixedValue=0.026

[FineRoot].MinimumNConc.FixedValue=0.009

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XValue.VariableName=[Eucalyptus].AboveGround.Wt

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,80,800,1600,4000,6400, 8000

[Leaf].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.30,0.25,0.15,.15,.15,.15, 0.14

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,50000,80000

[Branch].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=.15,.22,.22,.18,.13,.12

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.05,0.13,0.35,0.8,0.97,.98, .99,.999

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.X=0,500,1000,5000, 10000, 20000, 40000, 50000, 100000, 200000

[CoarseRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.XYPairs.Y=0.37,0.35, 0.33, 0.32, 0.3, .25, .2, .15, .12, .1

[FineRoot].DMDemands.Structural.DMDemandFunction.PartitionFraction.FixedValue=0.06

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.X=0, 2000, 10000, 20000, 100000

[Stem].WoodWt.WoodWt.WoodWtFactor.XYPairs.Y=0.7, 0.8, 0.95, 0.98, 0.99

[Stem].SenescenceRate.XYPairs.X=0,1000,10000,20000,30000,80000, 120000, 200000

[Stem].SenescenceRate.XYPairs.Y=0, 0, 0, 0, 0, 0, 0.01, 0.02

[FineRoot].SenescenceRate.FixedValue=0.00005

[Stem].DBH.DBHEquation.Expression=0.32*[Eucalyptus].IndividualTreeStemWt^0.33+2.5

[Stem].Ht.HeightFunction.Expression=2.4*[Eucalyptus].IndividualTreeStemWt^0.22-7

[Stem].BA.Expression=([Eucalyptus].Stem.DBH/2)^2*3.14159*[Eucalyptus].Population*1.4

[Stem].Vol.VolumeEquation.Expression=[Eucalyptus].Stem.Ht*[Eucalyptus].Stem.BA*(0.947*(([Eucalyptus].Stem.Ht-1.4)^-1.161)+0.317)

[Stem].Volub.Expression=[Eucalyptus].Stem.Vol-[Eucalyptus].Stem.VolBark*0.9

[Stem].BarkThickness.BarkThickness.XYPairs.X=0, 2, 7, 8, 10, 12, 13, 20

[Stem].BarkThickness.BarkThickness.XYPairs.Y=.2, .25, .28, .3, .4, .5, .6, .7

2 Validation

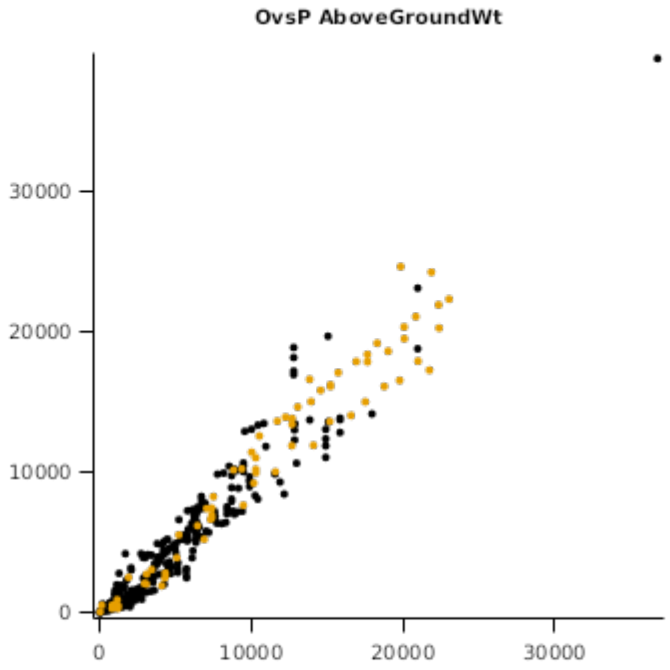
Validation datasets have been included to assist with validation during model development. Validation datasets cover a range of environmental (soil and climate) conditions, management options (populations, nitrogen rates, irrigation) and genetic backgrounds (different regions, provenence, clones). These datasets have been grouped and ordered alphebetically by site within a climatic zone. Graphs of model performance are provided for stocking, canopy development, biomass production, stem metrics, and soil water. Where a tropical or sub-tropical dataset did not include aboveground biomass, but instead a related parameter like stem volume or biomass, the latter was converted to aboveground biomass by a regression based on the rest of the validation dataset for that climatic region. However, this estimation was not conducted for temperate datasets.

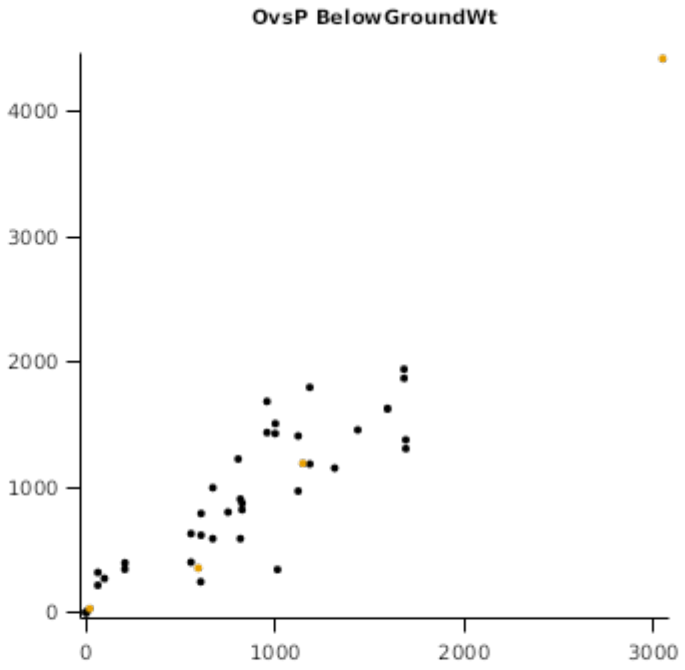
Observed data are shown compared to predictions, with statistics for model skill.

2.1 Combined Validation

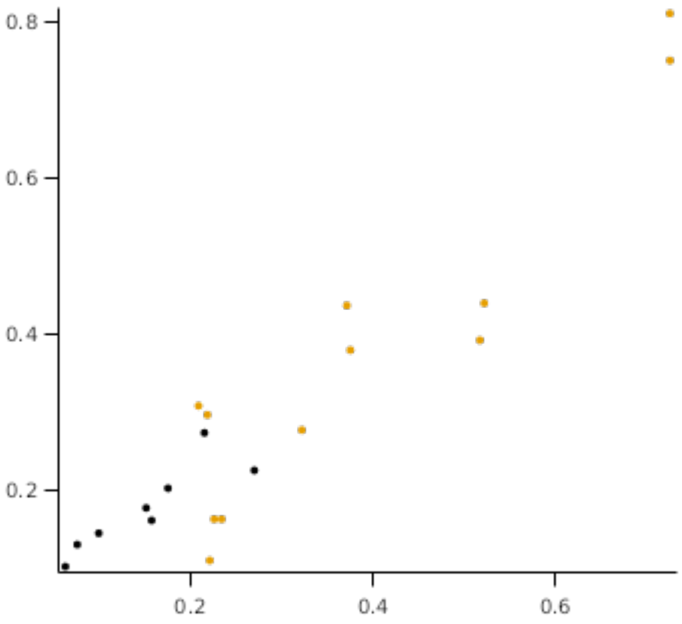
These graphs are for the combined datasets of *Tropical and SubTropical* and *Temperate* climatic zones.

Graphs from individual sites, particularly temporal trends of observed and predicted values, are available but currently disabled. If you wish to view these graphs, please download the validation from GitHub, run it, and enable those graphs and-or add others.

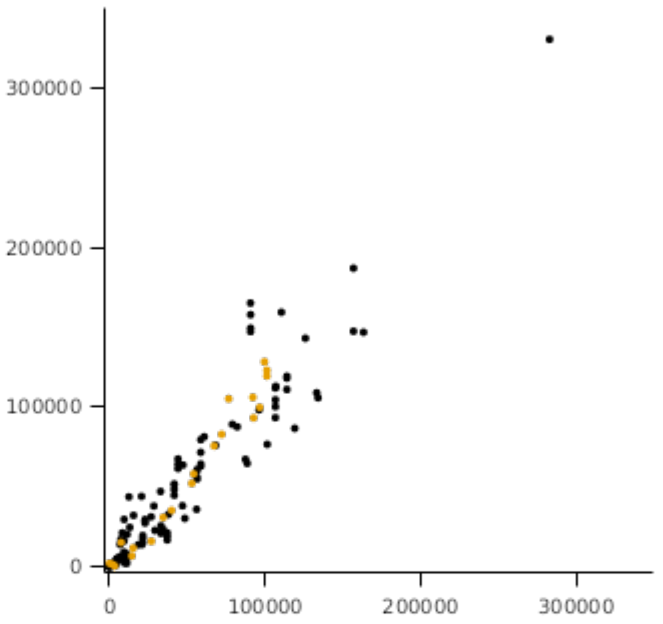

OvsP AboveGroundWt


OvsP BelowGroundWt

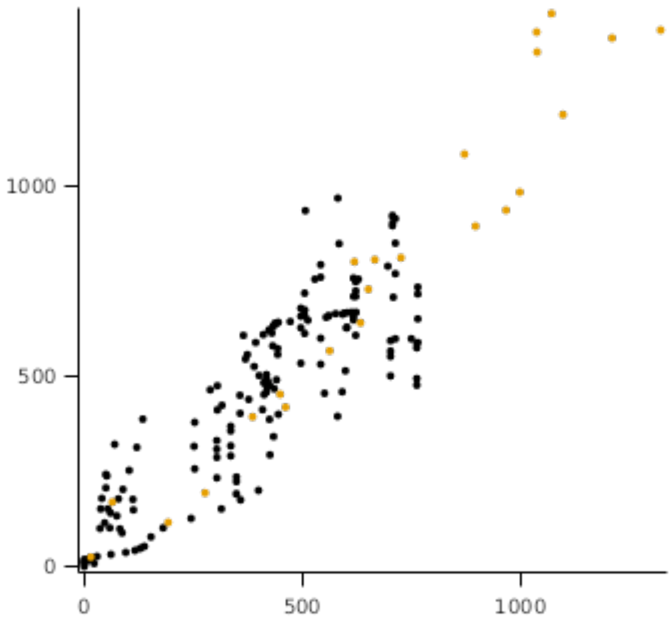
OvsP RootShootRatio



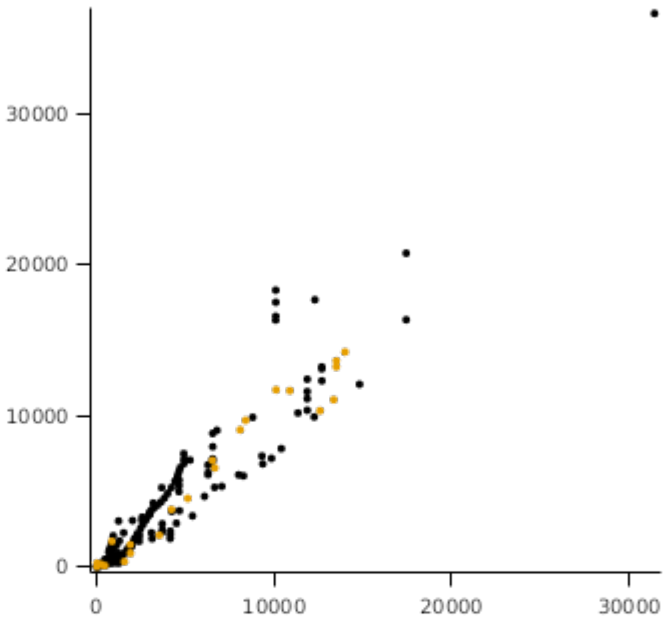
OvsP IndividualTreeStemWt

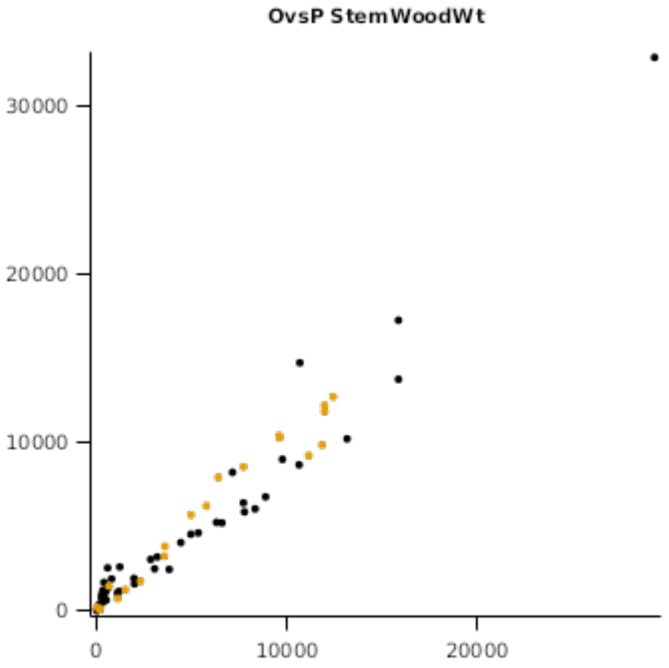


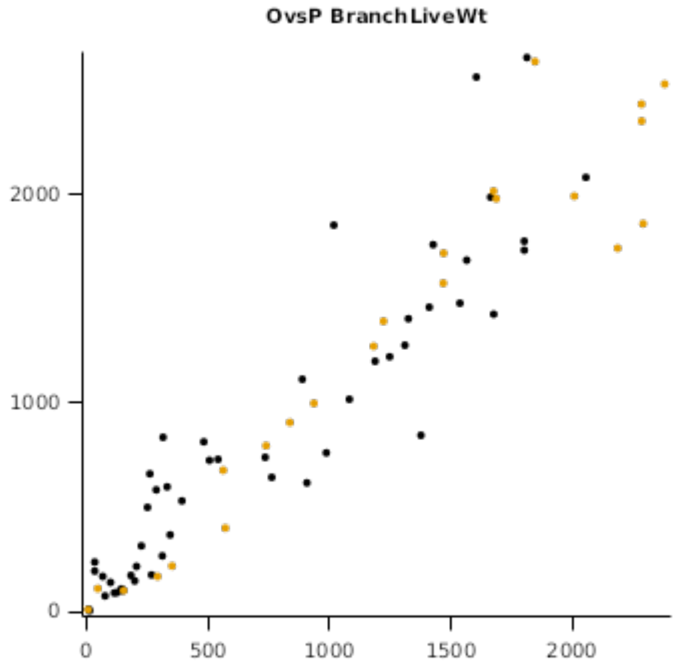
OvsP LeafLiveWt

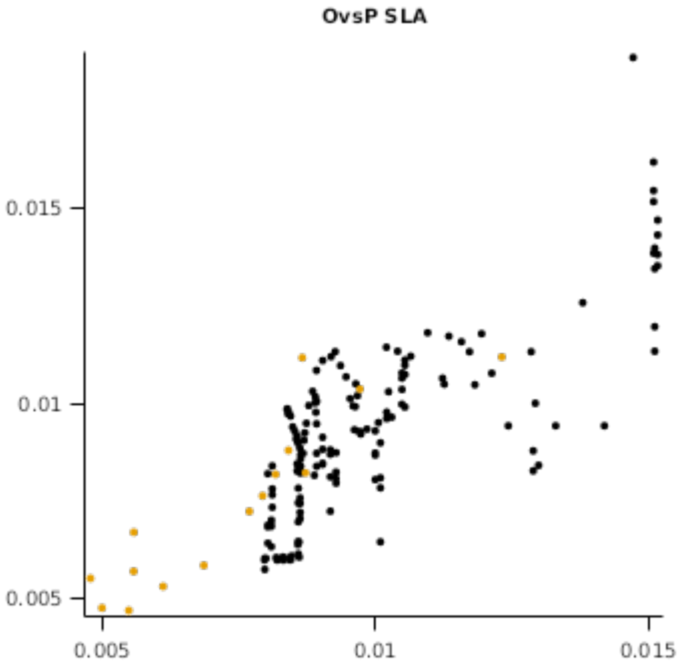


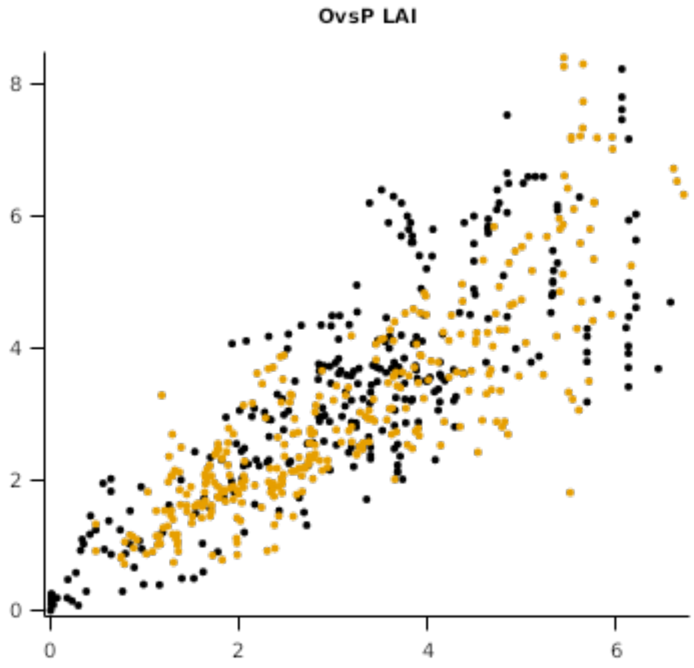
OvsP StemWt

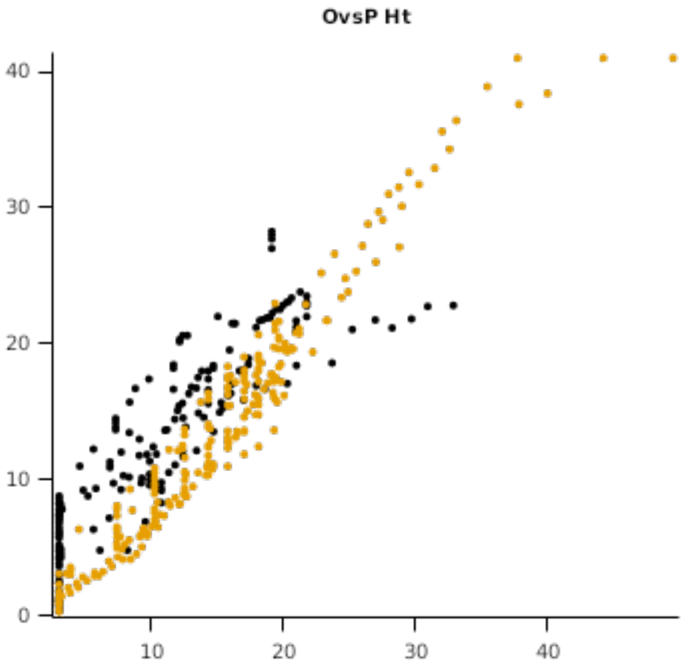


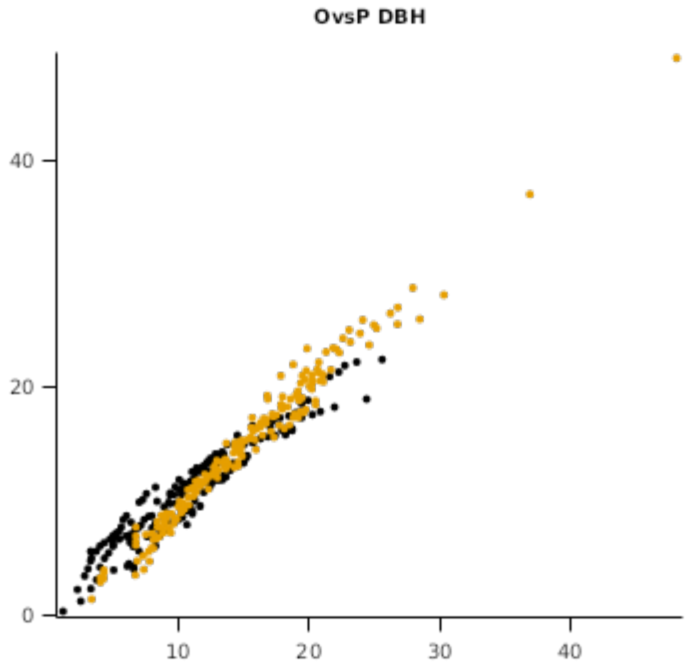

OvsP StemWoodWt
30000
20000
10000
0
0
10000
20000

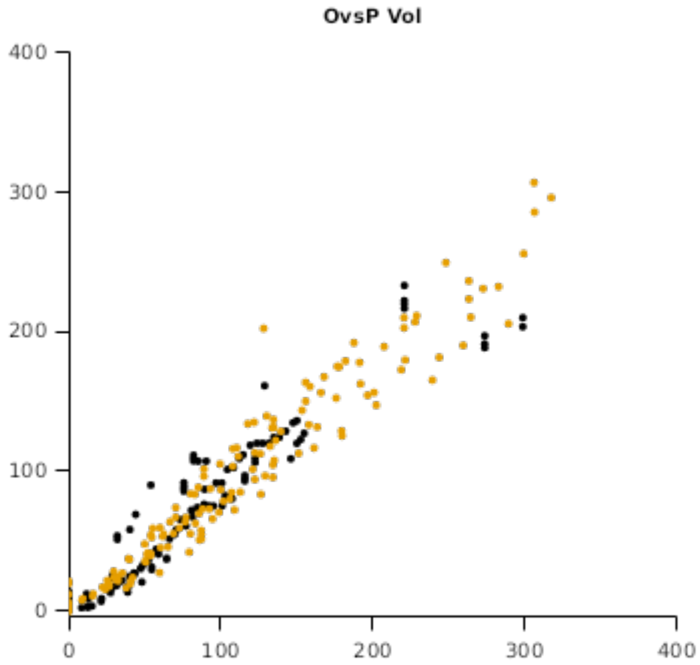

OvsP BranchLiveWt
2000
1000
0
0
500
1000
1500
2000


OvsP SLA
0.015
0.01
0.005
0.005
0.01
0.015


OvsP LAI
8
6
4
2
0
0
2
4
6


OvsP Ht
40
30
20
10
0
10
20
30
40

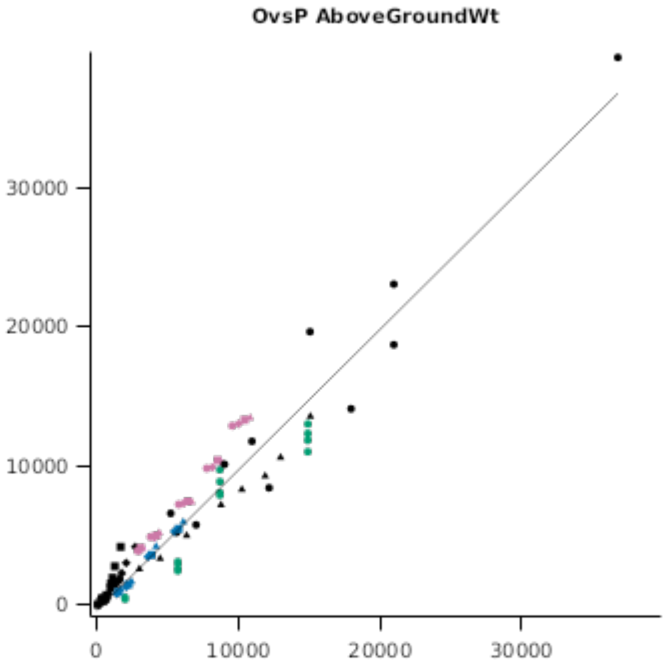

OvsP DBH
40
20
0
10
20
30
40



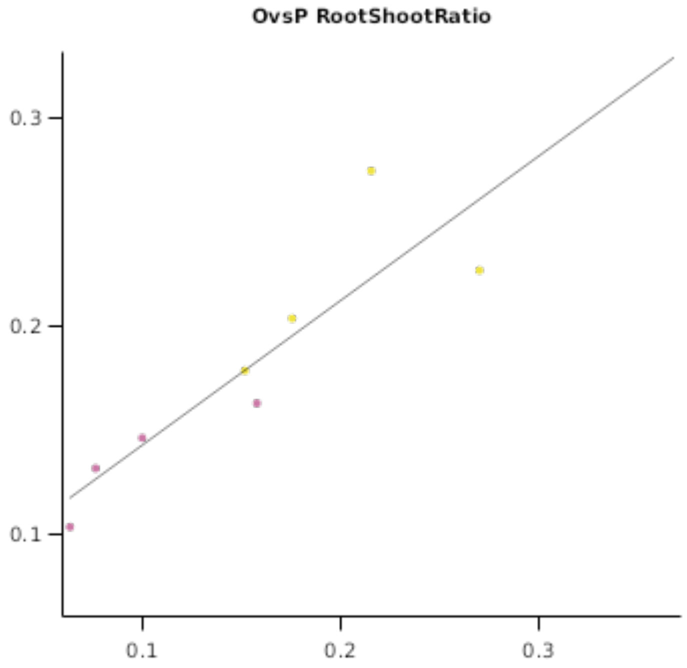
2.2 Tropical and SubTropical

2.2.1 Tropical and SubTropical Validation

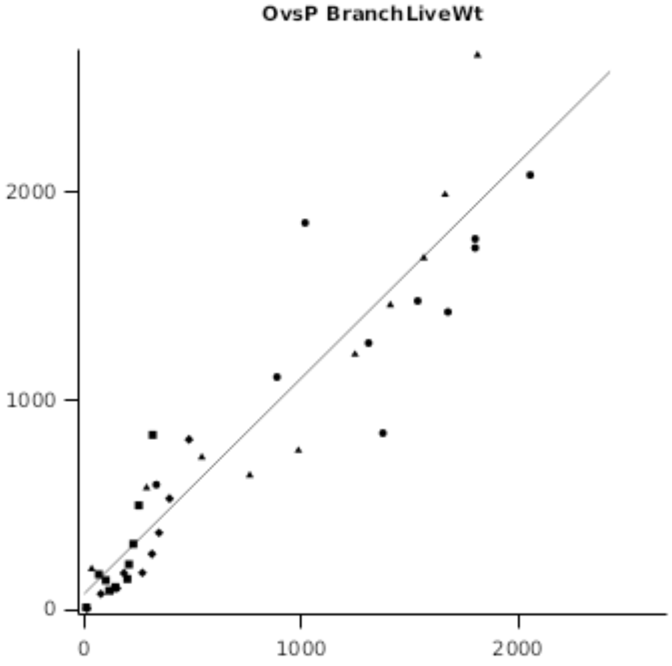
These graphs are for the *Tropical and SubTropical* datasets.



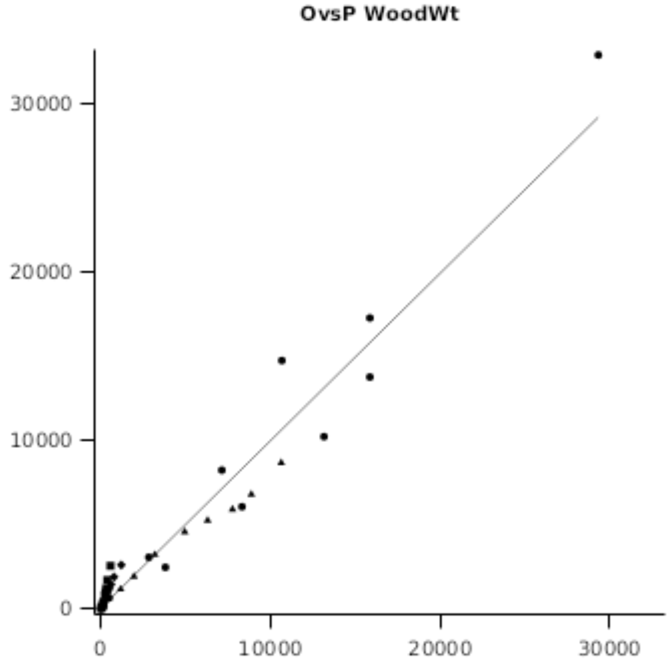
OvsP AboveGroundWt



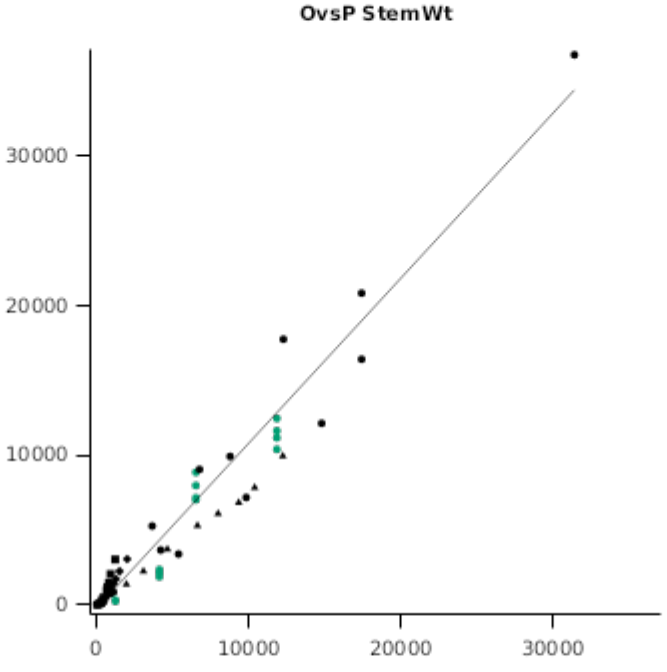
OvsP RootShootRatio



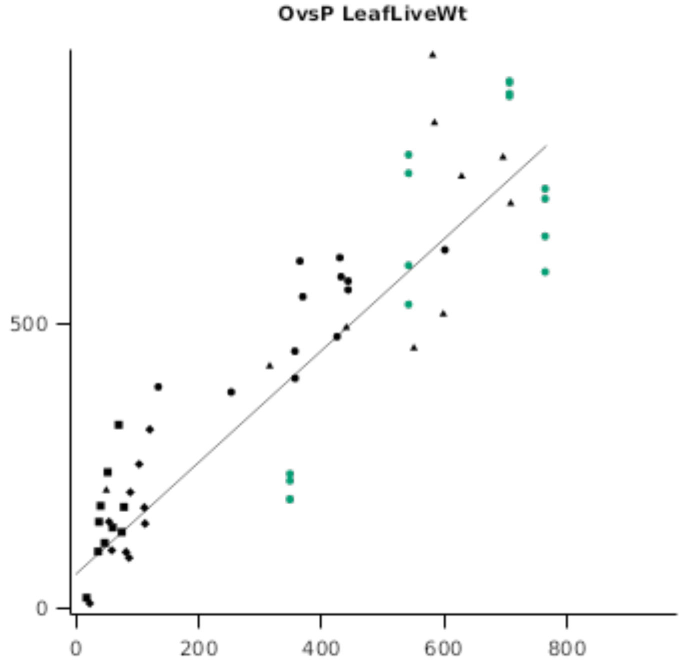
OvsP BranchLiveWt



OvsP WoodWt

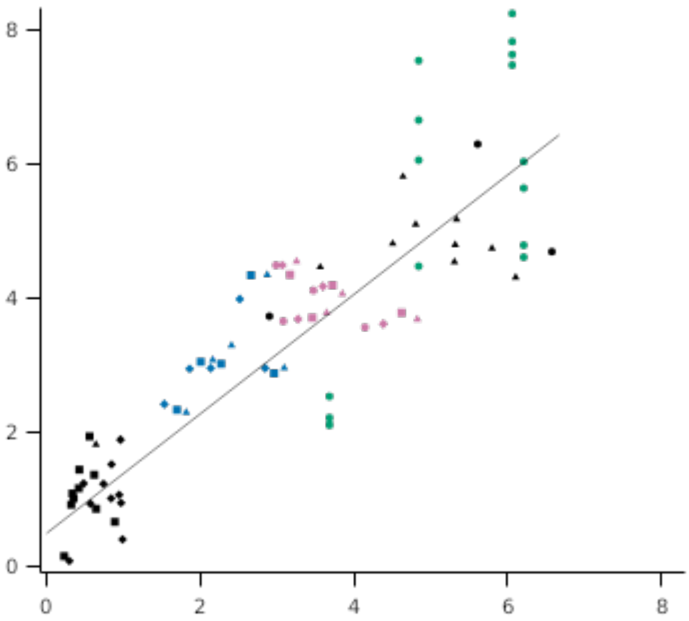


OvsP StemWt

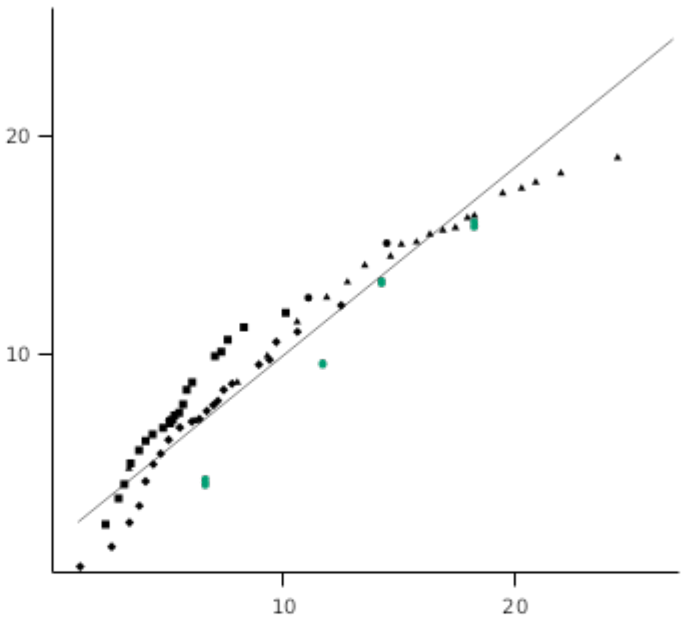


OvsP LeafLiveWt

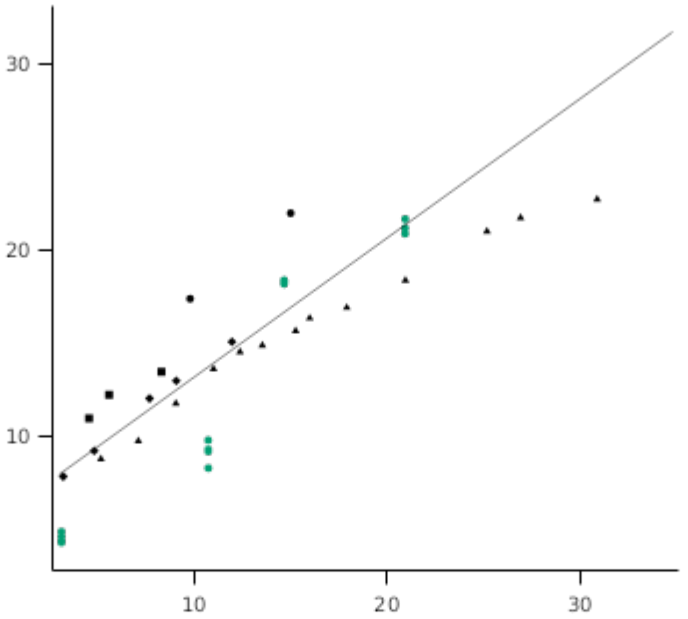
OvsP LAI



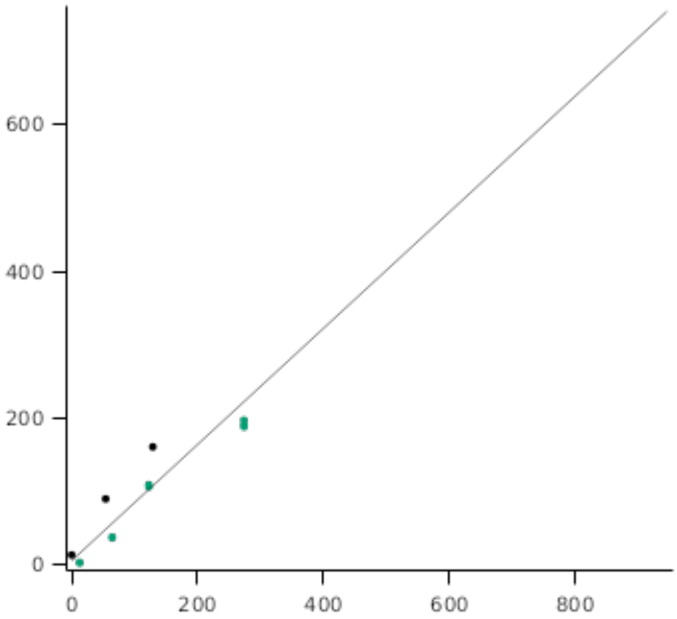
OvsP DBH



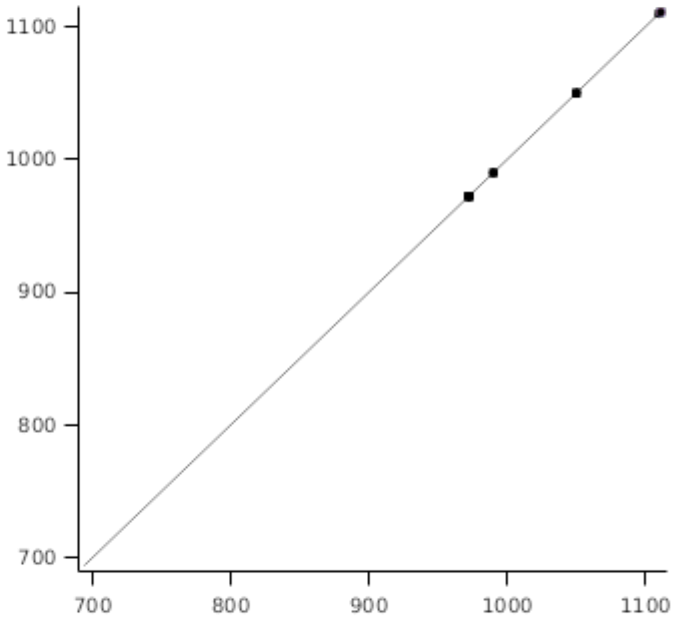
OvsP Ht



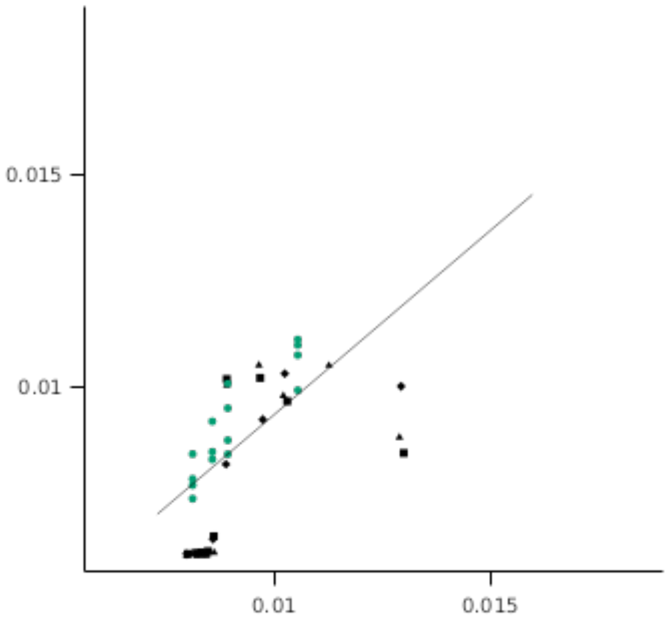
OvsP Vol



OvsP Stemspha



OvP SLA



2.2.2 Australia Egrandis

2.2.2.1 CoffsHarbour

Data are from Turner, 1986. The research is also reported in Byrne, 1989 and Bradstock, 1981. These data are from a chronosequence of approximately even-aged stands of native forests of *E grandis* and include the oldest stands simulated so far by the APSIM Eucalyptus model. They are the only native forest data in this set of simulations; all other simulations are of plantations.

2.2.2.2 Gympie

This experiment is described in Cromer et al., 1993 and Cromer et al., 1993. Some soil input data are from Ross, 1991. Experimental treatments were factorial combinations of two levels each of irrigation and fertilisation applied to *E. grandis.* Most growth response was to fertiliser, which included NPK, but only N is simulated, which assumes that other nutrients were present at adequate levels.

List of experiments.

Experiment Name	Design (Number of Treatments)
Gympie	Treatment (4)

2.2.2.2.1 Gympie

2.2.2.3 Wagga

This experiment is described in Polglase et al., 1995, Snow et al., 1999, Snow et al., 1999, Myers et al., 1996, and Myers et al., 1998. The experiment included effluent-irrigated *E. grandis* and some weeds; only the irrigated treatement was included here.

2.2.3 Brazil Egrandis and others

2.2.3.1 Aracruz

These data are described in Almeida, 2003 and Almeida et al., 2004. Two clones of *E. grandis* are included that had measured differences in root:shoot ratio. These differences were simulated by specifiying partitioning targets as a genetic property.

List of experiments.

Experiment Name	Design (Number of Treatments)
Aracruz	Cult (2)

2.2.3.2 Curvelo

These data are described in Borges, 2009. Two clones of the hybrid E. grandis x E. urophylla were included (C3334, C3336), but their measured differences were not significantly different. Hence, clonal differences were not simulated by specifiying partitioning targets as a genetic property.

List of experiments.

Experiment Name	Design (Number of Treatments)
Curvelo	Site (2)

2.2.3.2.1 Curvelo

2.2.3.3 Itacambira

These data are described in Borges, 2009. Two clones of the hybrid E. grandis x E. urophylla were included (C3334, C3336), but their measured differences were not significantly different. Hence, clonal differences were not simulated by specifiying partitioning targets as a genetic property.

List of experiments.

Experiment Name	Design (Number of Treatments)
Itacambira	Site (2)

2.2.3.3.1 Itacambira

2.2.3.4 Luisantonio

These data are described in Melo et al., 2015. One clone of the hybrid *E. grandis x E. urophylla* was grown with 4 rates of N fertilisation.

List of experiments.

Experiment Name	Design (Number of Treatments)
Luisantonio	N (4)

2.2.3.4.1 Luisantonio

2.2.3.5 Mogiguacu

These data are described in Melo et al., 2015. One clone of the hybrid *E. grandis x E. urophylla* was grown with 4 rates of N fertilisation.

List of experiments.

Experiment Name	Design (Number of Treatments)
Mogiguacu	N (4)

2.2.3.5.1 Mogiguacu

2.2.3.6 MonteDourado

These data are described in Silva, 2006. One clone of the hybrid *E. grandis x E. urophylla* was included, and it was grown at two sites on contrasting soils.

2.2.3.7 Paulistania

These data are described in Melo et al., 2015. One clone of the hybrid *E. grandis x E. urophylla* was grown with 4 rates of N fertilisation.

List of experiments.

Experiment Name	Design (Number of Treatments)
Paulistania	N (4)

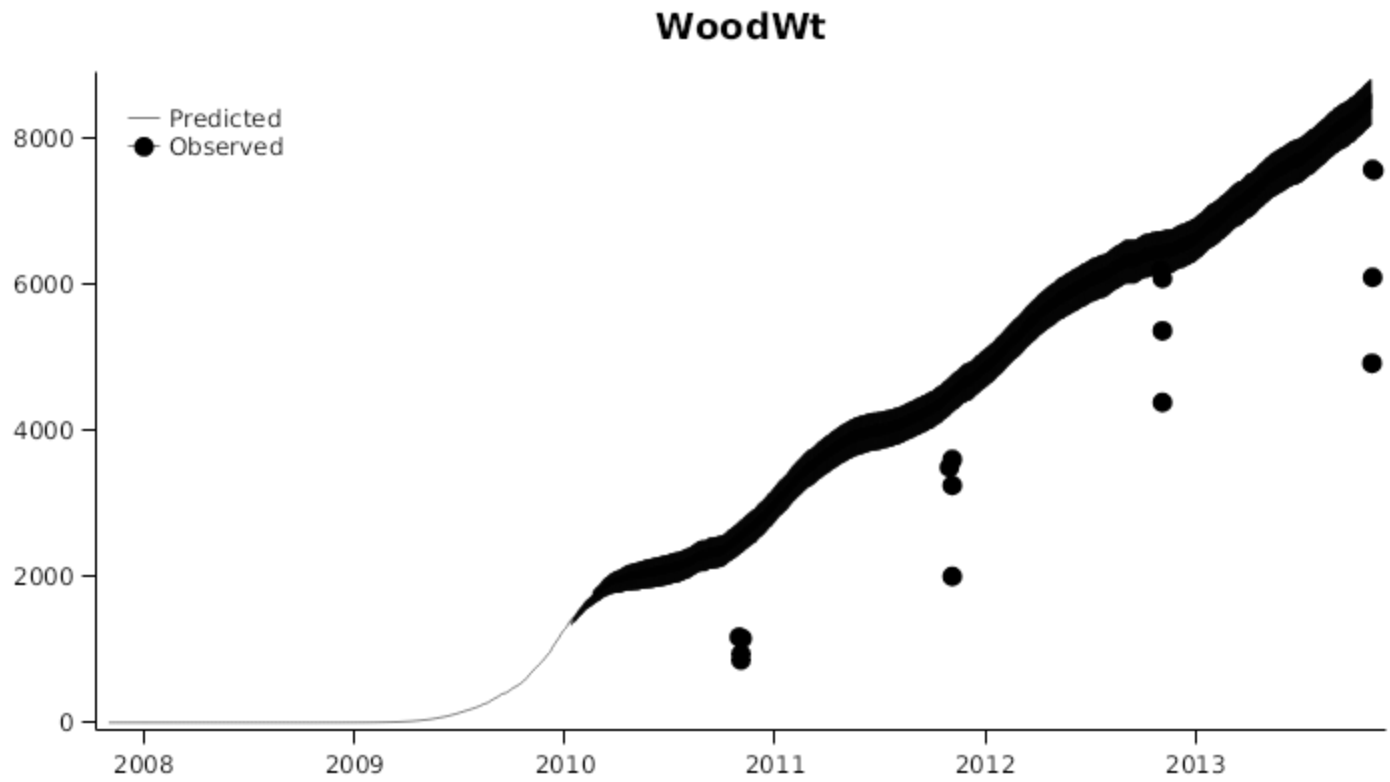
2.2.3.8 Ribasdoriopardo

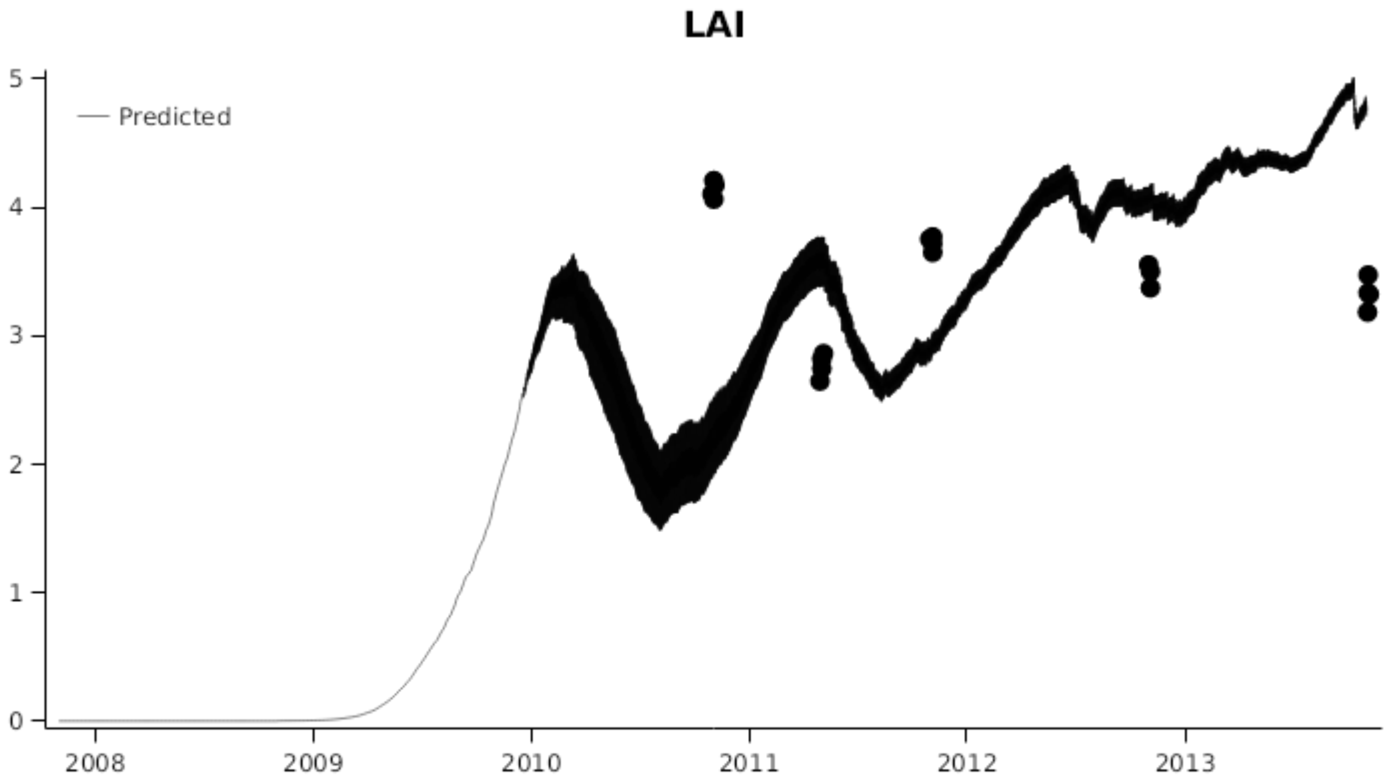
These data are described in Melo et al., 2015. One clone of the hybrid *E. grandis x E. urophylla* was grown with 4 rates of N fertilisation.

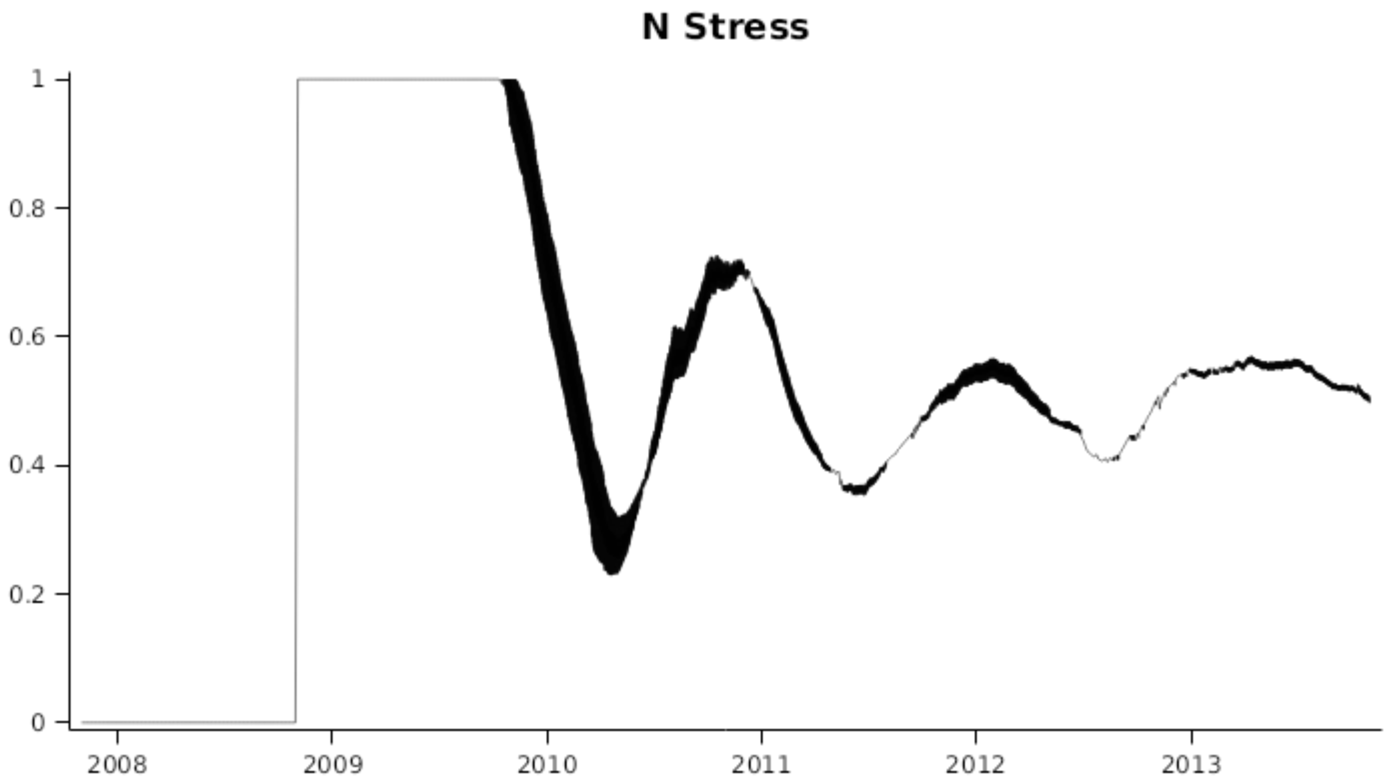
List of experiments.

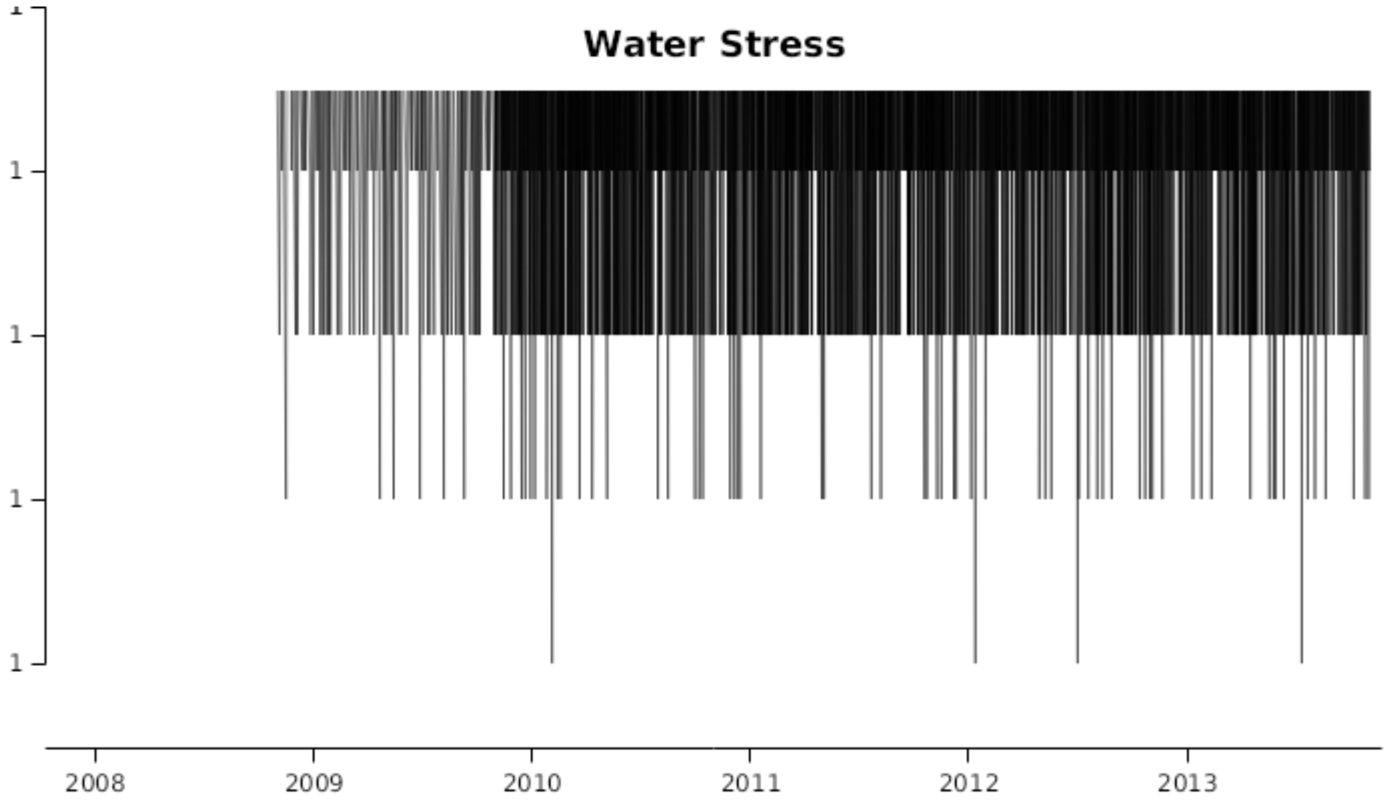
Experiment Name	Design (Number of Treatments)
Ribasdoriopardo	N (4)

2.2.3.8.1 Ribasdoriopardo


WoodWt
Predicted
Observed
8000
6000
4000
2000
0
2008
2009
2010
2011
2012
2013


LAI
Predicted
5
4
3
2
1
0
2008
2009
2010
2011
2012
2013





2.2.3.9 SantanadoParaiso

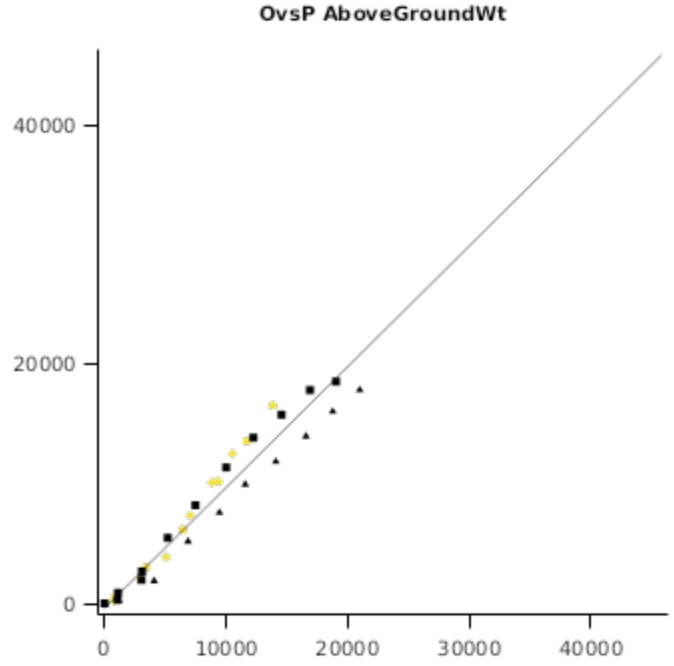
These data are described in Nogueira, 2005. One clone of the hybrid *E. grandis* was included, and it was grown in a factorial experiment of two levels each of irrigation and fertilisation.

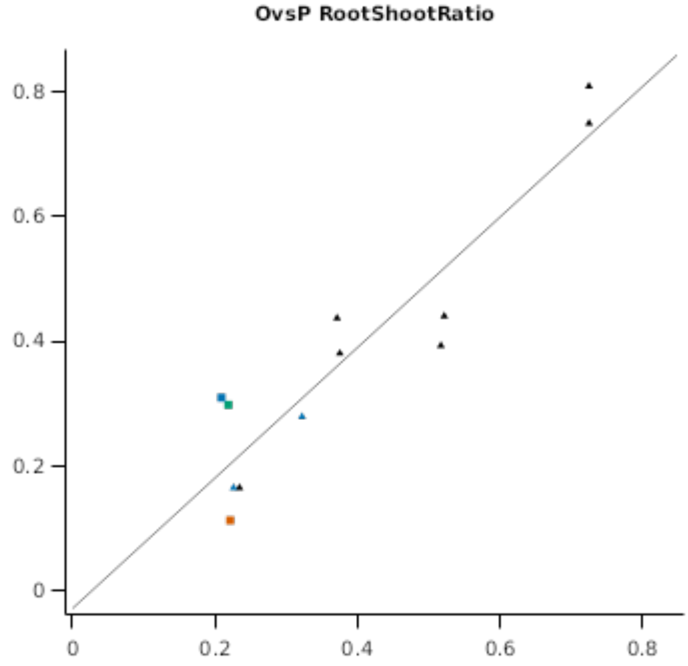
List of experiments.

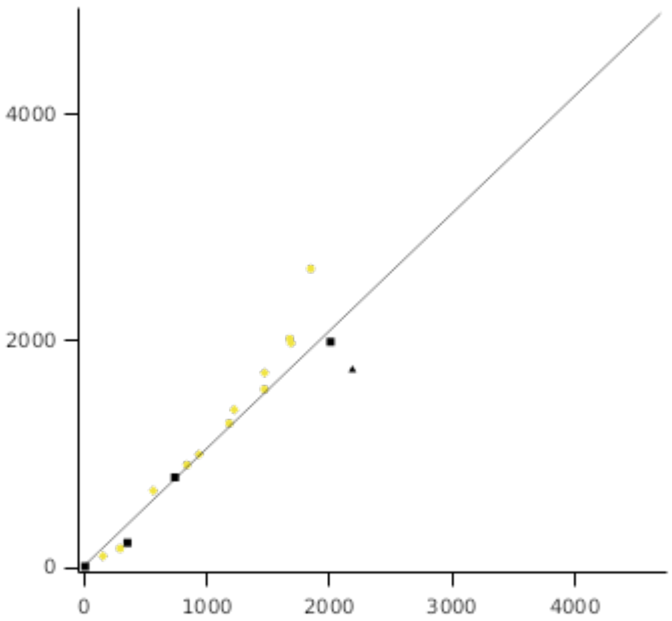
Experiment Name	Design (Number of Treatments)
SantanadoParaiso	Irr x N (4)

2.3 Temperate

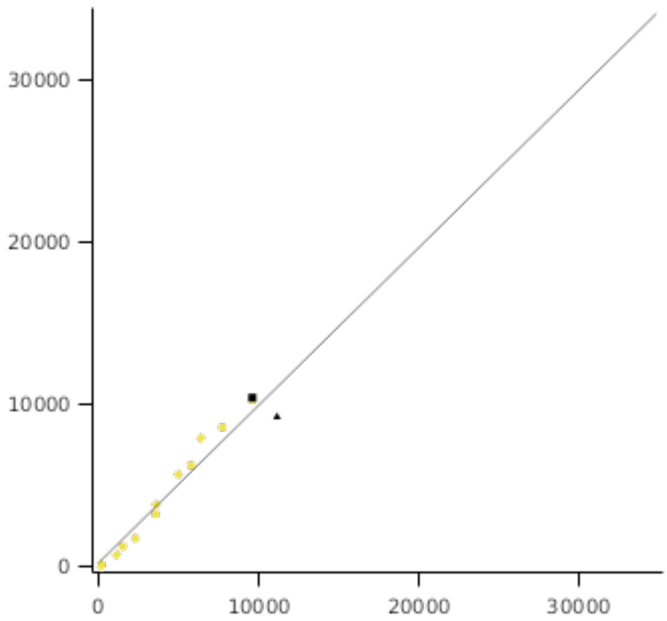
2.3.1 Temperate Validation



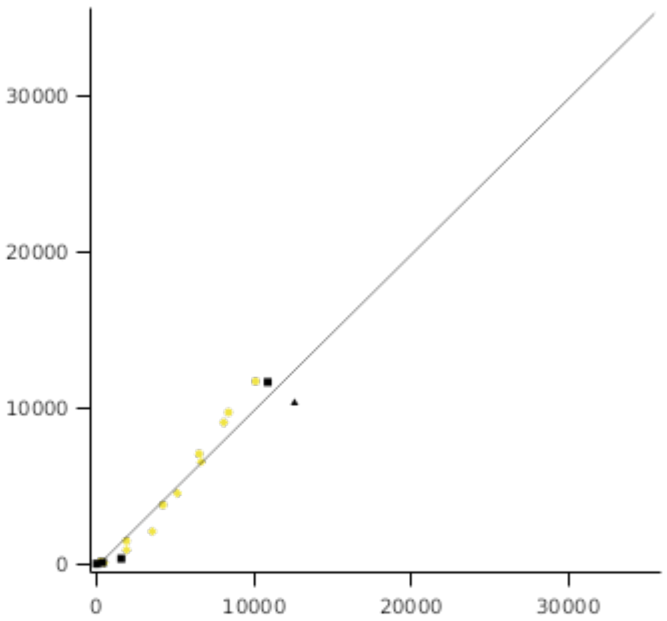




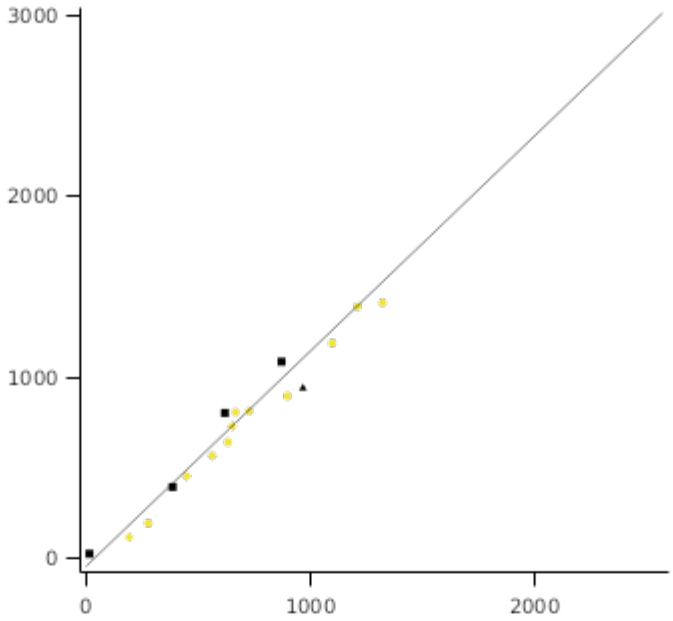
OvsP BranchLiveWt



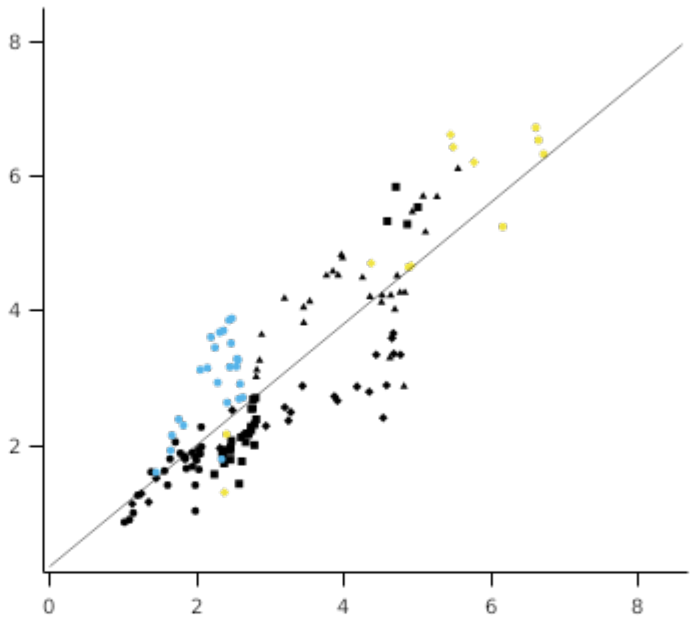
OvsP WoodWt

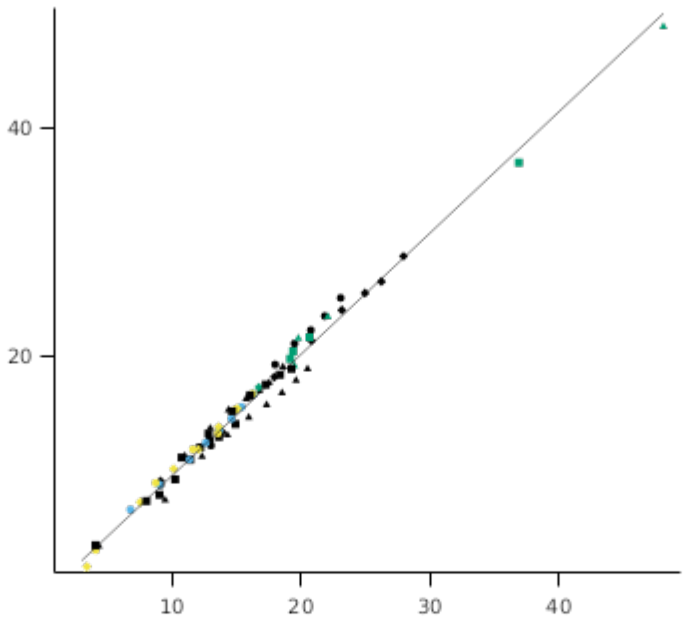


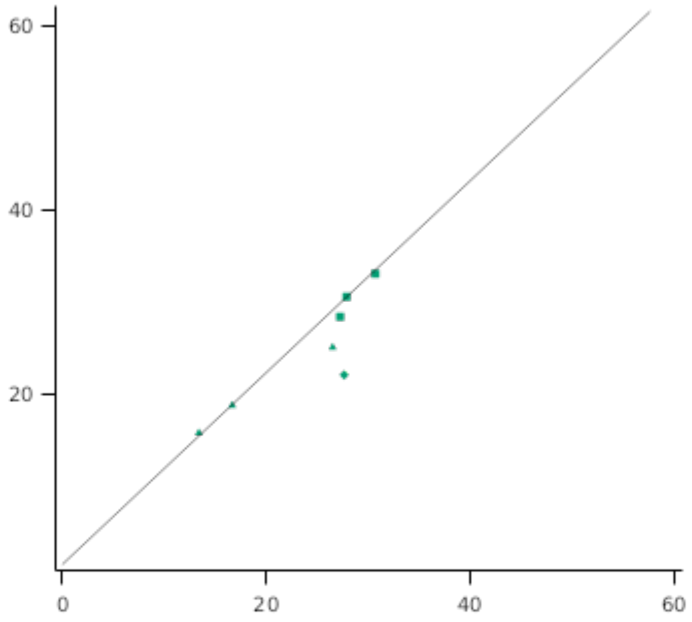
OvsP StemWt

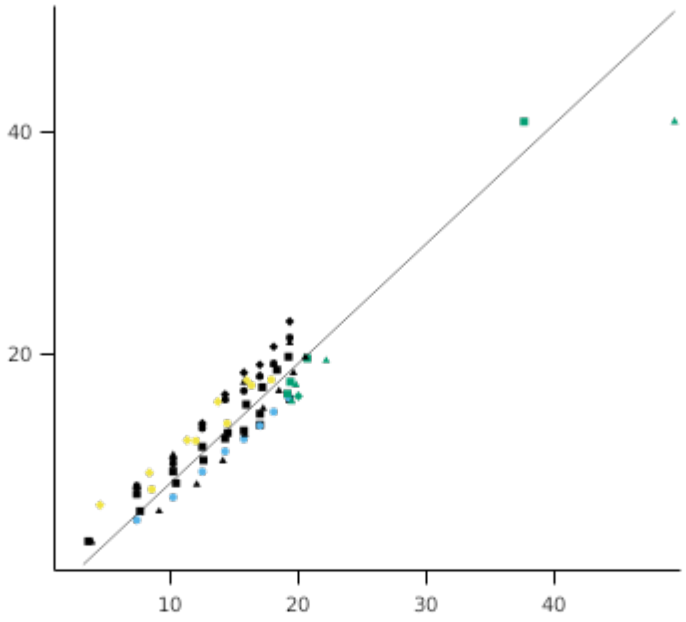


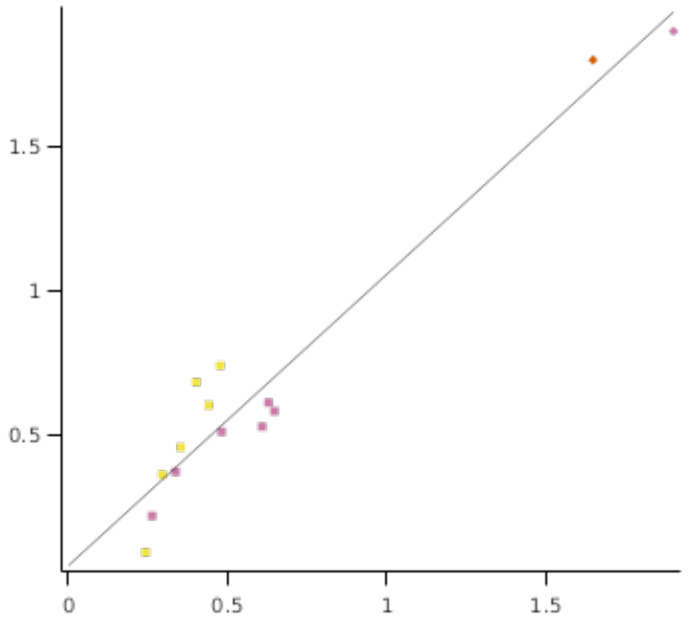
OvsP LeafLiveWt

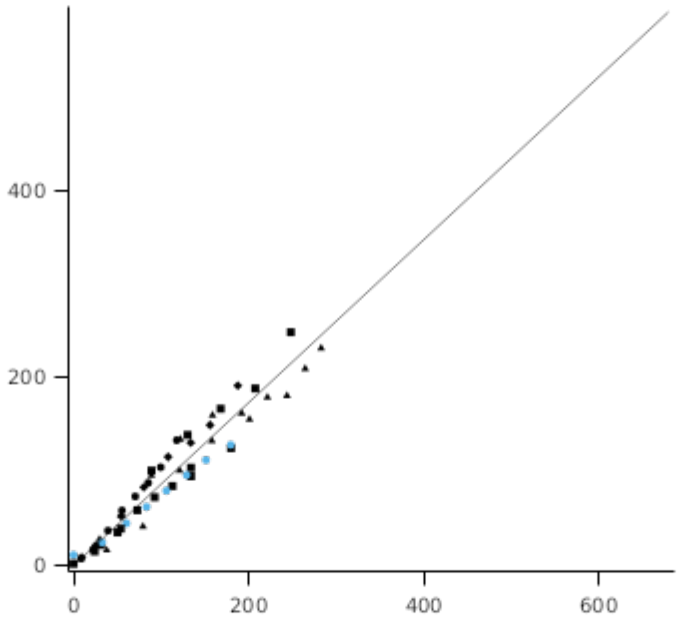

OvsP LAI

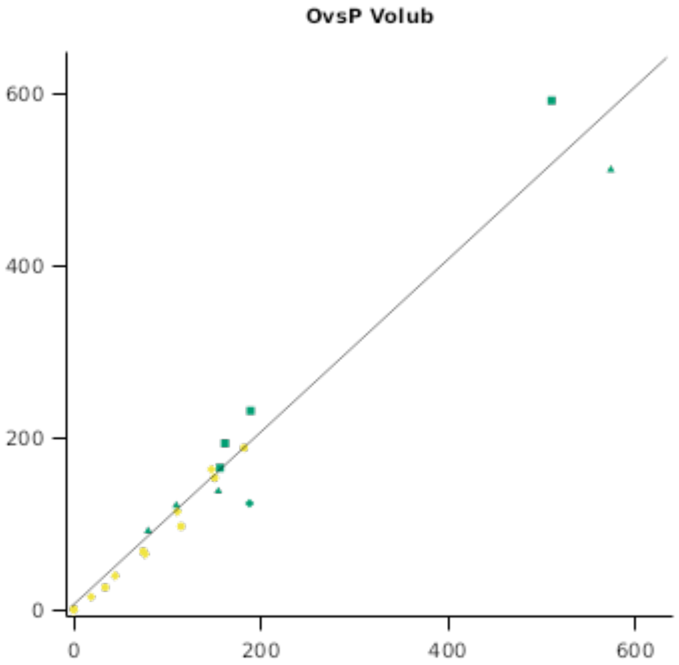

OvsP DBH

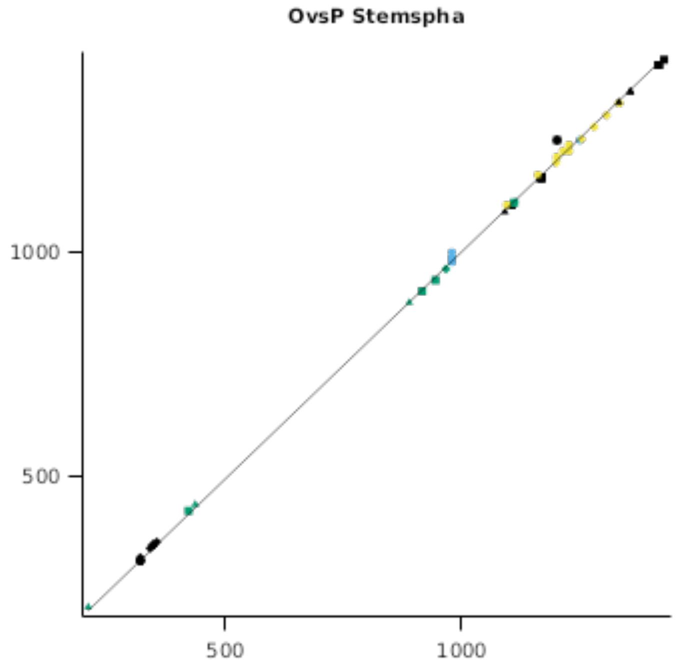

OvsP BA

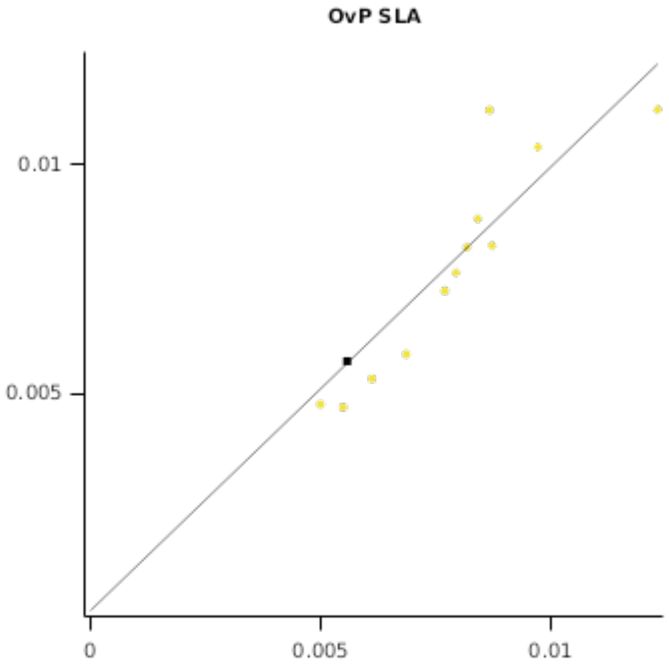

OvsP Ht


OvsP BarkThickness


OvsP Vol


OvsP Volub
600
400
200
0
0
200
400
600


OvsP Stemspha
1000
500
500
1000


OvP SLA
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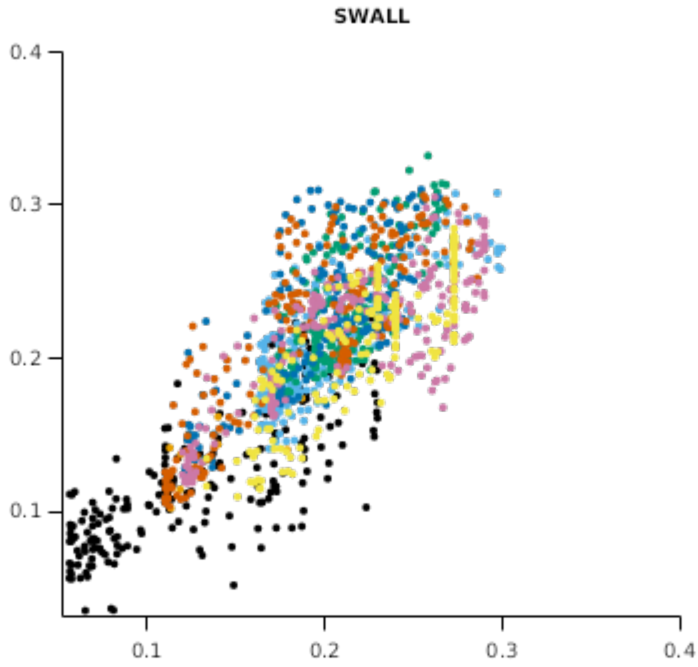
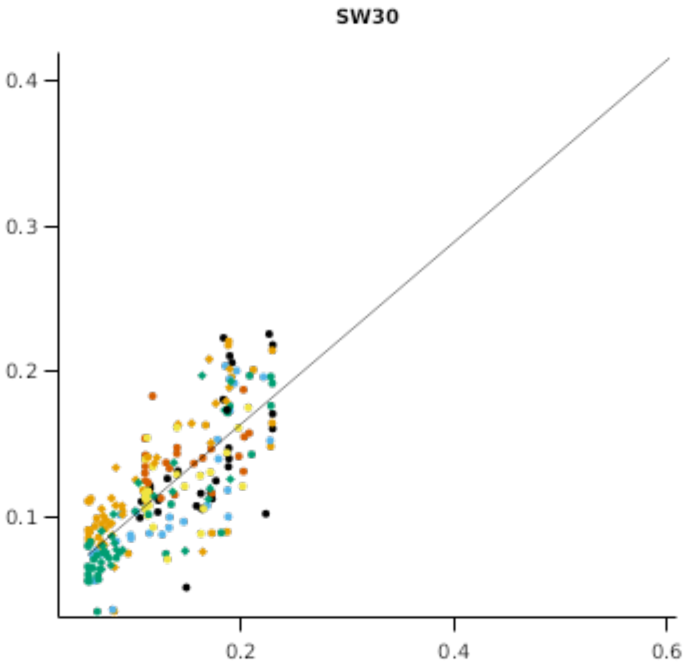
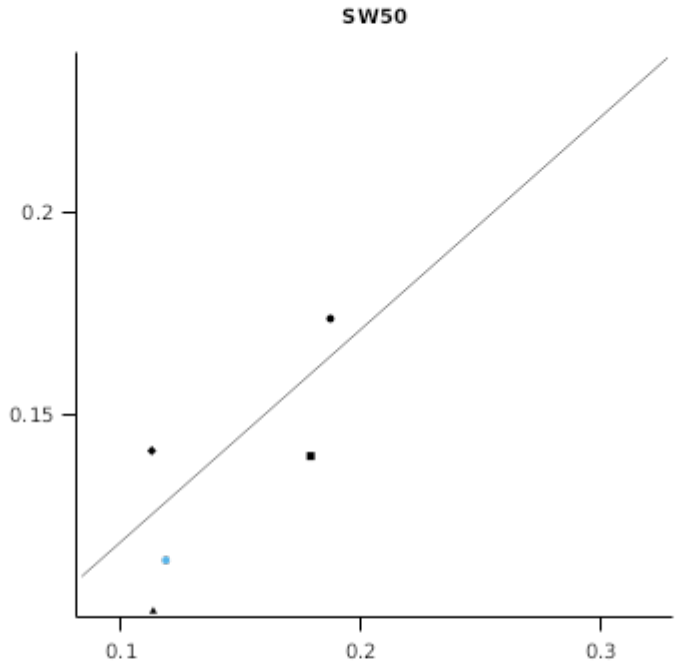
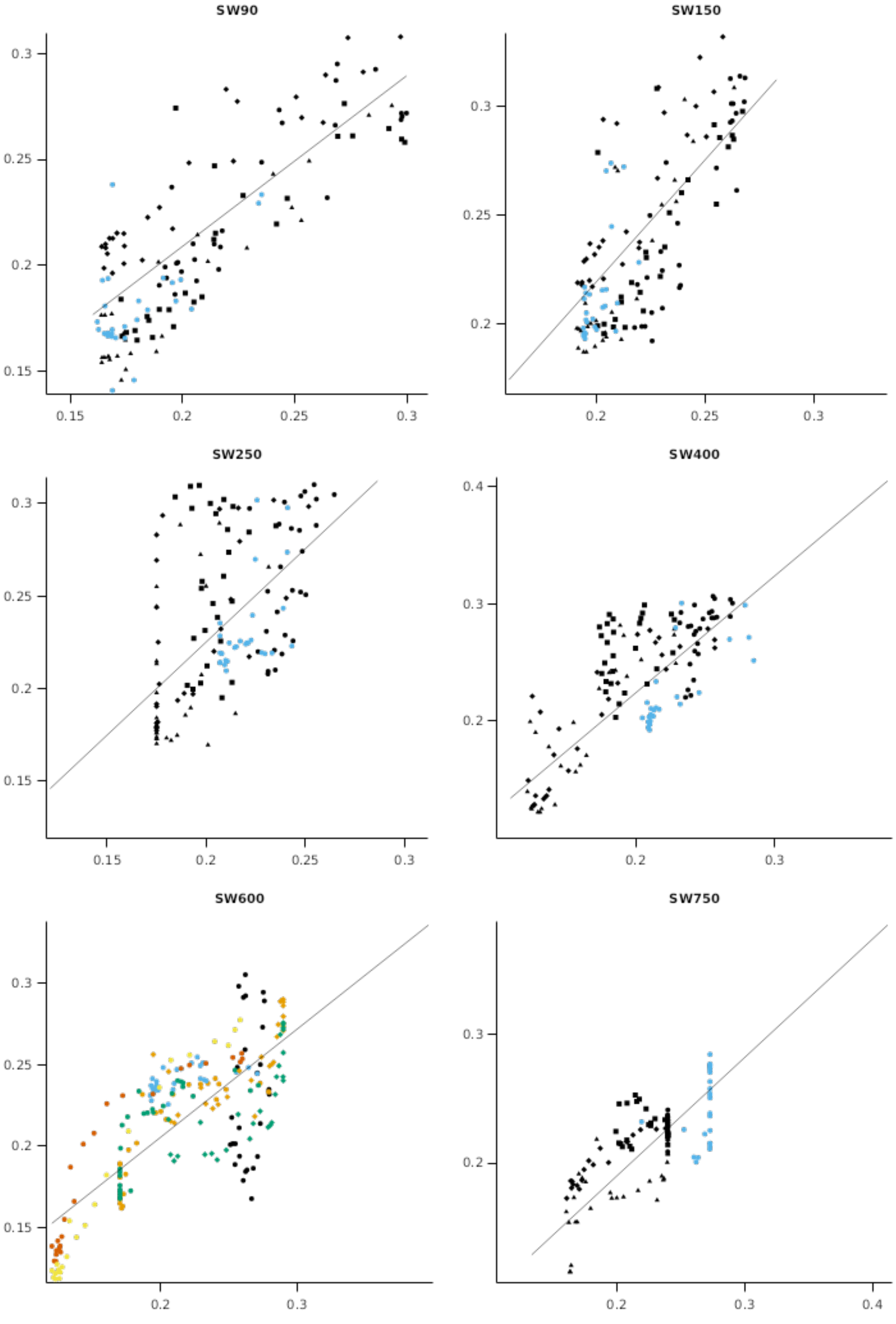
0.005
0
0.005
0.01


SWALL
0.4
0.3
0.2
0.1
0.1
0.2
0.3
0.4


SW30
0.4
0.3
0.2
0.1
0.2
0.4
0.6


SW50
0.2
0.15
0.1
0.2
0.3


SW90
0.3
0.25
0.2
0.15
0.15
0.2
0.25
0.3
SW150
0.3
0.25
0.2
0.2
0.25
0.3
SW250
0.3
0.25
0.2
0.15
0.15
0.2
0.25
0.3
SW400
0.4
0.3
0.2
0.2
0.3
SW600
0.3
0.25
0.2
0.15
0.2
0.3
SW750
0.3
0.2
0.2
0.3
0.4

2.3.2 DroughtRiskSites

These experiments are described in Mendham et al., 2011, White et al., 1996, White et al., 1998, White et al., 2009, White et al., 2010 and White et al., 2014. Experimental treatments were combinations of stocking and N fertilisation starting 2 years after planting. Additional data were provided by D. Mendham. A second rotation is described in these papers and data included in the observed file, but treatments were reallocated at the begining of the second rotation, and coppice rather than seedlings were used in most treatments for the second rotation. It would be useful and possible to include coppicing in the Eucalyptus model, but this has not yet been attempted. Other models in APSIM provide a basis for including coppicing, e.g. gliricidia, and lucerne.

List of experiments.

Experiment Name	Design (Number of Treatments)
ScottRiver	N (4)
Wellstead	N (4)
BoyupBrook	N (4)

2.3.3 Forico

These data describe adjacent plantations of E. globulus and E. nitens, with part of the E. nitens plantation being thinned. The site was known as St Georges Road. We thank G. Holz, K. Joyce, and L. Cannon of Forico for data and other information about the site (formally the site was owned or managed by Gunns, North Forest Products and APPM).

List of experiments.

Experiment Name	Design (Number of Treatments)
Forico	StGRd (3)

2.3.4 FSAGrowthPlots

These data are for Forestry SA growth plots, and were provided Jim O'Hehir, University of South Australia. As they are in a region with a water table containing nitrate that can be reached by roots, these components were added to the simulation. However, nitrate was not described as a concentration in groundwater, but instead nitrate was applied as nitrate fertiliser at 2.5 m depth or greater four times per year. Thinned and unthinned stands are included.

List of experiments.

Experiment Name	Design (Number of Treatments)
FSAGPs	A (4)

2.3.5 Furadouro

This experiment is described in Madeira et al., 1990, Madeira et al., 1995, Pereira et al., 2012, Madeira et al., 2002, Fabi\~ao et al., 1995, K\atterer et al., 1995, Quilh\'o et al., 2001, Pereira et al., 1994, Pereira et al., 1989, and Fontes et al., 2006. Experimental treatments were combinations of irrigation and fertilisation applied to *E. globulus.* Most growth response was to fertiliser, which included NPK, but only the IL treatment was simulated here, which assumes that nutrients othere than N were also present at adequate levels.

List of experiments.

Experiment Name	Design (Number of Treatments)
Furadour	o (1)

2.3.6 Lewisham

This experiment is described in White et al., 1998, White et al., 1996, and Worledge et al., 1998. The experiment included a comparison of *E. globulus* and *E. nitens* under supplemented-rainfed and well-irrigated conditions. Rainfed plots were up-slope of the irrigated plots. Soil was mostly derived from basalt, which was present at a shallow depth.

List of experiments.

Experiment Name	Design (Number of Treatments)
Lewisham	E (2)

2.3.7 Shepparton

This experiment is described in Bren et al., 1993, Baker, 1998, Baker et al., 2005, Duncan et al., 1998, Wong et al., 2000, Hopmans et al., 1990, and Stewart et al., 1990. Additional data and information were provided by T.G. Baker and H. Stewart. The experiment included coppiced and seedling *E. grandis* and *E. globulus*, which were irrigated with sewerage effluent. The soil was a duplex, and there for poorly drained. Eearly growth was quite impressive, but by 10 years trees had noticably mortality due to pests and diseases, and also due to other conditions that did not suit these species (poor drainage, frost).

List of experiments.

Experiment Name	Design (Number of Treatments)
Shepparton	E (2)

2.3.8 Westfield

This experiment is described in Smethurst et al., 1997, Smethurst et al., 2003, Smethurst et al., 2004, Smethurst et al., 2004, Misra et al., 1998, Misra et al., 1998, and Resh et al., 2003. The experiment included nil to high cumulative rates of N and P fertilisers in an *E. nitens* plantation. Other research suggested that three was little or no response to the P component of the fertiliser. Very high rates of fertiliser might have started to induced a base cation deficiency (Ca, Mg or K) by the latter stage of the rotation, as some acidification had occurred, but this was not investigated further.

List of experiments.

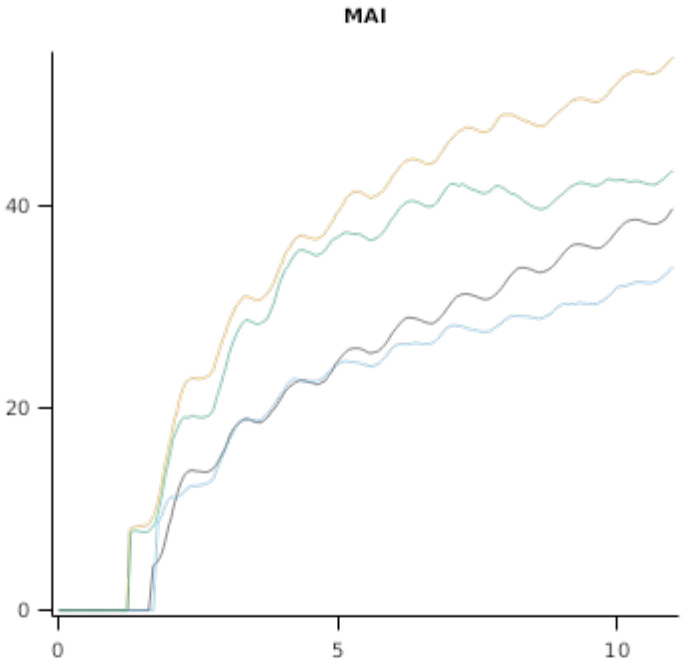
Experiment Name	Design (Number of Treatments)
Westfield	T (6)

3 Sensibility

A series of sensibility tests have been employed to test the behaviour of the model in regions not explicitly included in the previous test set. Furthermore, these tests explore the emergent behaviour of the model under a range of changing climate, fertility and management scenarios to ensure that simulated patterns agree with expected behaviours.

3.1 MAI in SE Australia

Representative growth rates for Eucalyptus grandis have been published for south-eastern Australia (Victoria and South Australia) by [Wong2000forecasting]. Some of the sites within this publication had previously been used for improved pasture and had minimal fertility constraints. Simulations for 4 sites have been presented here to capture a range of environmental conditions. Stocking rates used at each site match those obtained at each site within the published study. MAI at age 10 years should be approximately 10 cubic metres per annum for Mount Worth and Stockdale and approximately 20 cubic metres per annum for Tostaree and Mount Lofty. Climate data has been taken from nearby towns and common soil properties have been used for all sites, with soil properties reflecting a relatively high state of fertility.

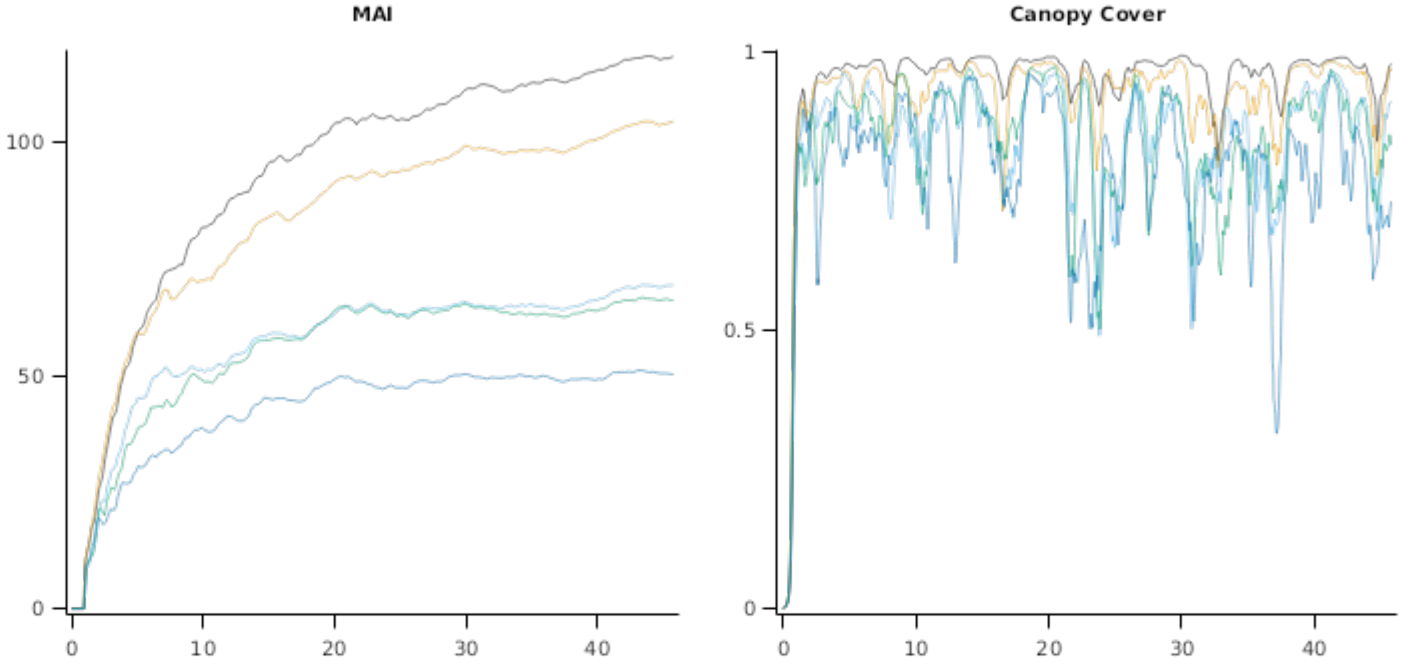


3.2 Response to Rainfall

Eucalyptus should respond to changes in rainfall such that peak MAI should increase with rainfall. Long term "climax LAI" should also increase with mean annual rainfall. This simulation experiment explores the changes in MAI and canopy cover along a rainfall gradient within SE Queensland Australia. Mean annual rainfall decreases from approximately 1200 mm to 660 mm. Fertiliser is applied within the simulations to remove any confounding of results due to site fertility. Data from Specht, 1972 show that canopy cover should be almost complete for the wetter sites in this study, and decrease to approximately 50% at the drier sites.

List of experiments.

Experiment Name	Design (Number of Treatments)
Climate	Site (5)

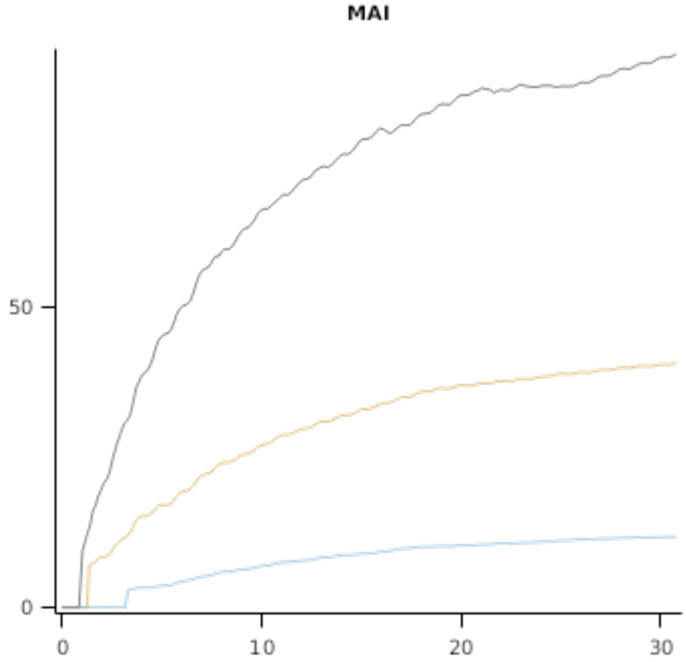


3.3 Response to Soil Fertility

Site fertility is an important driver of the pattern of tree growth rates. As site fertility declines, the long term growth rate (e.g. MAI) should also decrease, but the time to obtaining peak MAI should increase. This sensibility test uses a single location in SE Queensland at which Eucalyptus grandis occurs naturally. A range of soil fertility states are applied in this experiment. Peak MAI should decrease with decreasing fertility, but the time required to achieve this should increase.

List of experiments.

Experiment Name	Design (Number of Treatments)
Fertility	Level (3)



3.4 Reponse to N Fertilizer

Eucalyptus responses to rate of fertiliser are often asymptotic, the plateau of which is determined by other limiting factors (Rubilar et al., 2018). In the sensibility tests presented here, soil from Wodonga, Australia, was used as the basis for the simulations, except soil organic C and C:N were set to represent site 1 in Columbia in Albaugh et al., 2015 and Rubilar et al., 2018. Two climates are used in these simualtions ('WodongaI0ClimateWodonga' and 'WodongaI0ClimateCoffs'. Management was set similar to site 1 in Rubilar et al., 2018, i.e. E grandis was fertilised at 2 years of age and the 3-year stem volume response assessed at 5 years of age. For a highly responsive site in Columbia, a plateau in growth response occurred at about 800 kg N/ha, when it was speculated that other factors became limiting.

In 'WodongaI0ClimateWodonga', a low rainfall site (739 mm/year average longterm), the response to N was simulated to plateau at a rate of about 800 kg N/ha. The N rate inflexion point here is similar to that in Rubilar et al., 2018, but the limiting factor above this N rate in this simulation was mainly water, whereas in Albaugh et al., 2015 we can specualte that it was base cation deficiency.

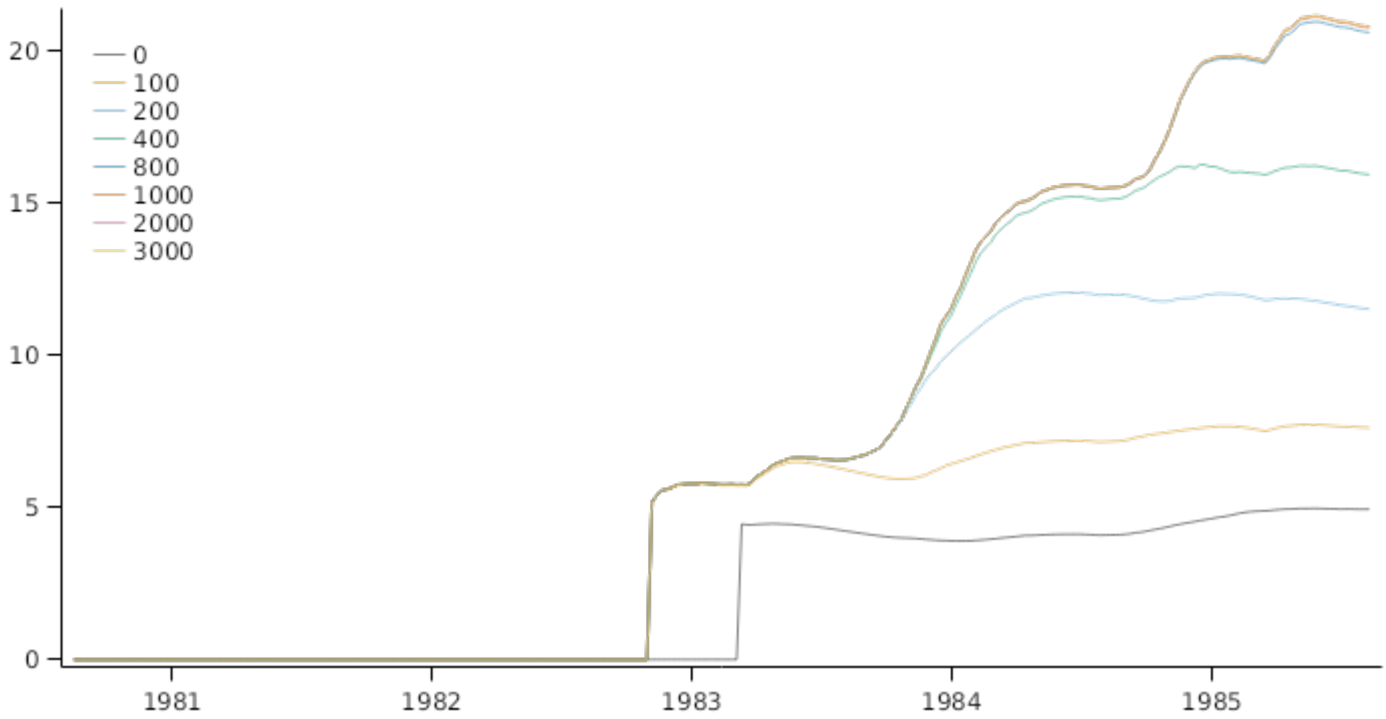
In 'WodongaI0ClimateCoffs', a high rainfall site (1635 mm/year average longterm), the water limitation was removed and the response to N has not plateaued even at a rate of 3000 kg N/ha.

Values of MAI and other outputs are in the range of expectation.

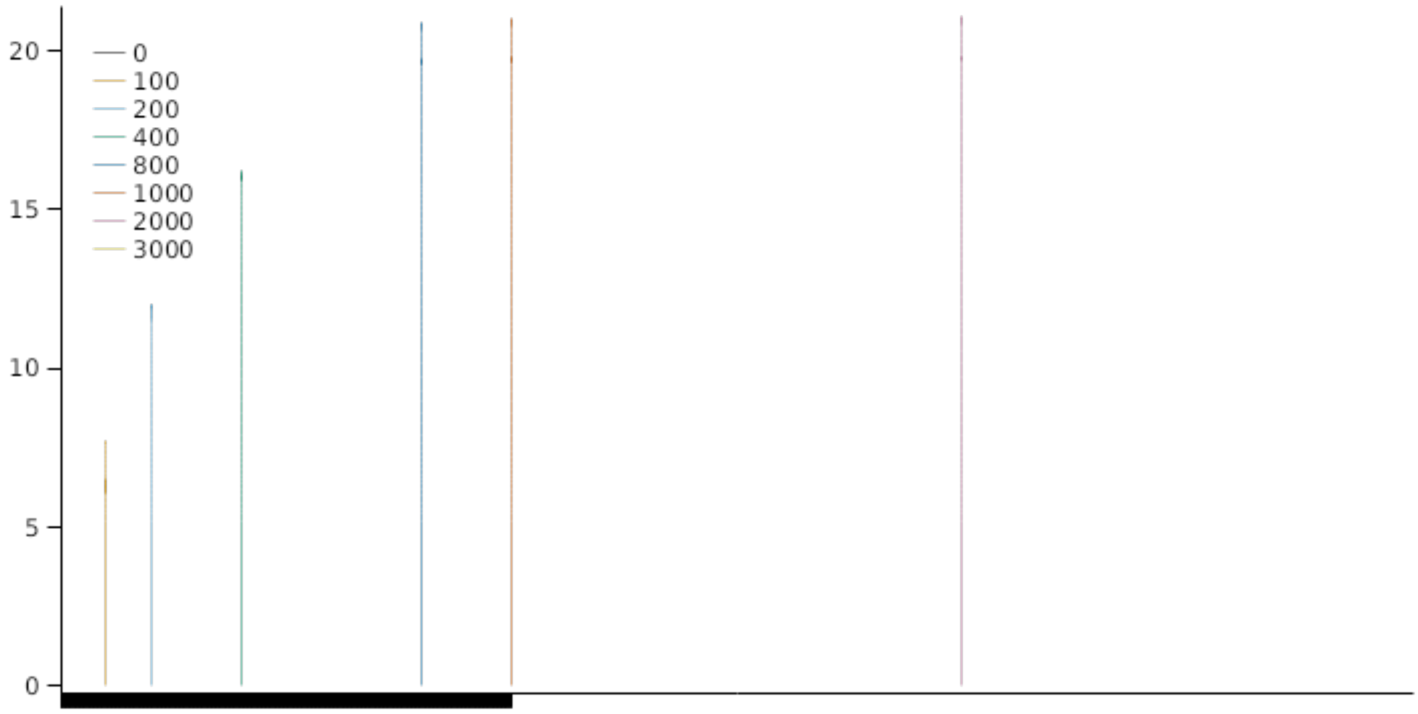
List of experiments.

Experiment Name	Design (Number of Treatments)
WodongaI0ClimateWodonga	N (8)
WodongaI0ClimateCoffs	N (8)

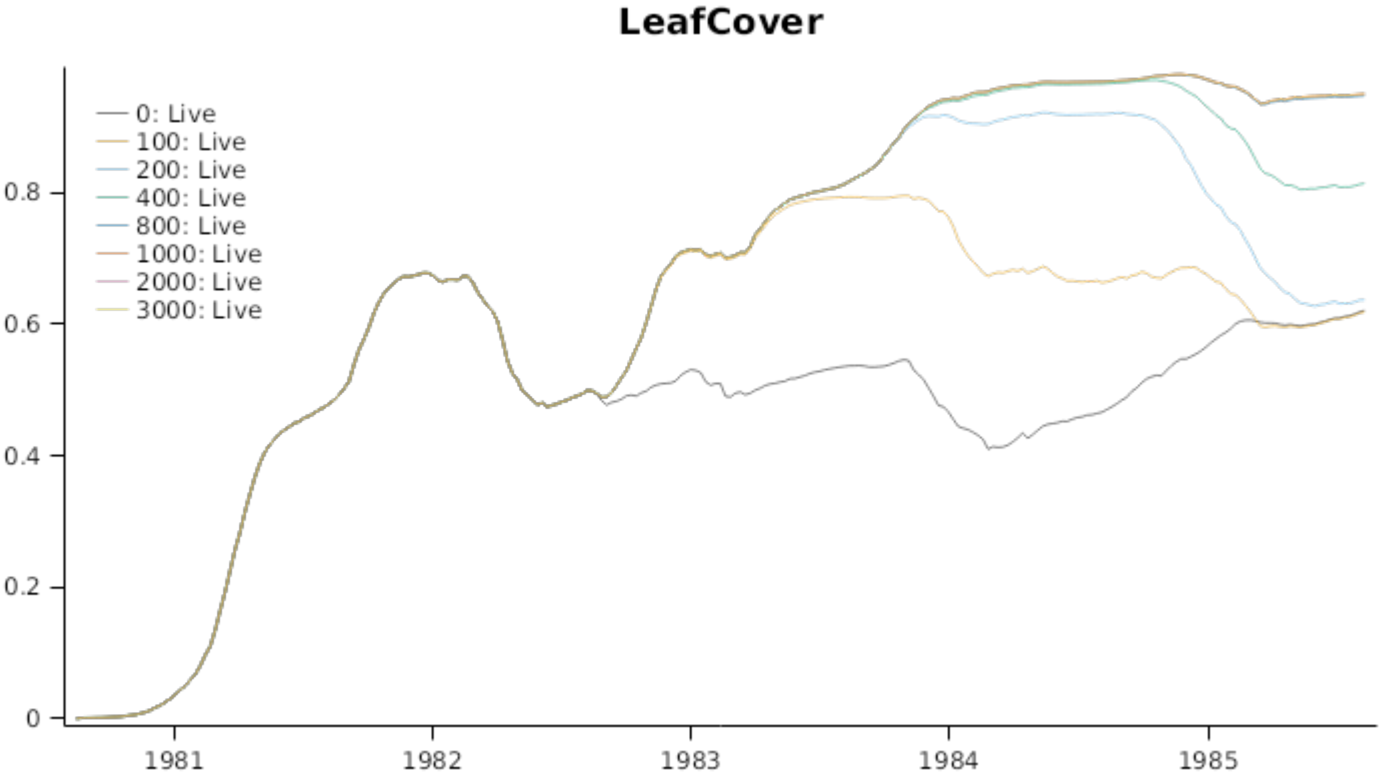
3.4.1 WodongaI0ClimateWodonga



MAI



StemVolVersusNRate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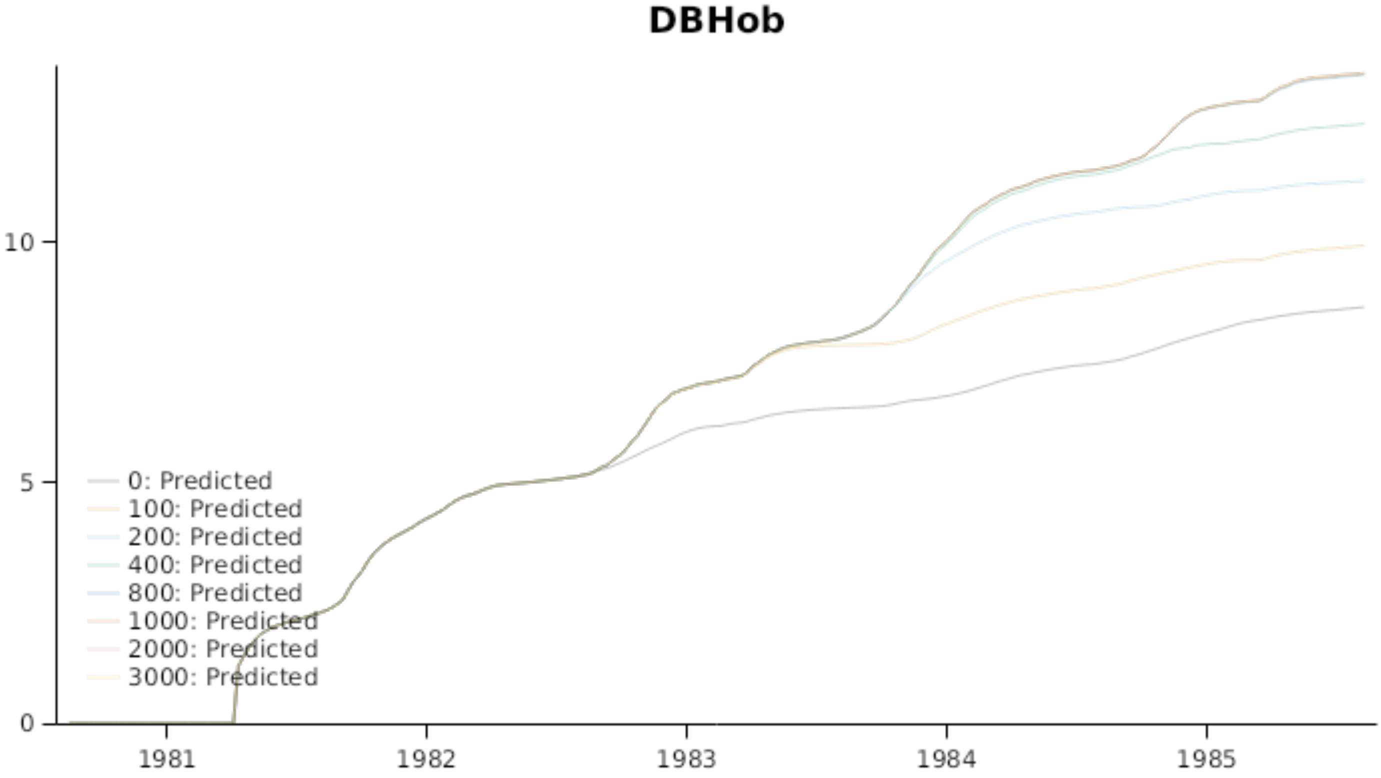
100: Live
200: Live
400: Live
800: Live
1000: Live
2000: Live
3000: Live
0.8
0.6
0.4
0.2
0
1981
1982
1983
1984
1985


DBHob
0: Predicted
100: Predicted
200: Predicted
400: Predicted
800: Predicted
1000: Predicted
2000: Predicted
3000: Predicted
10
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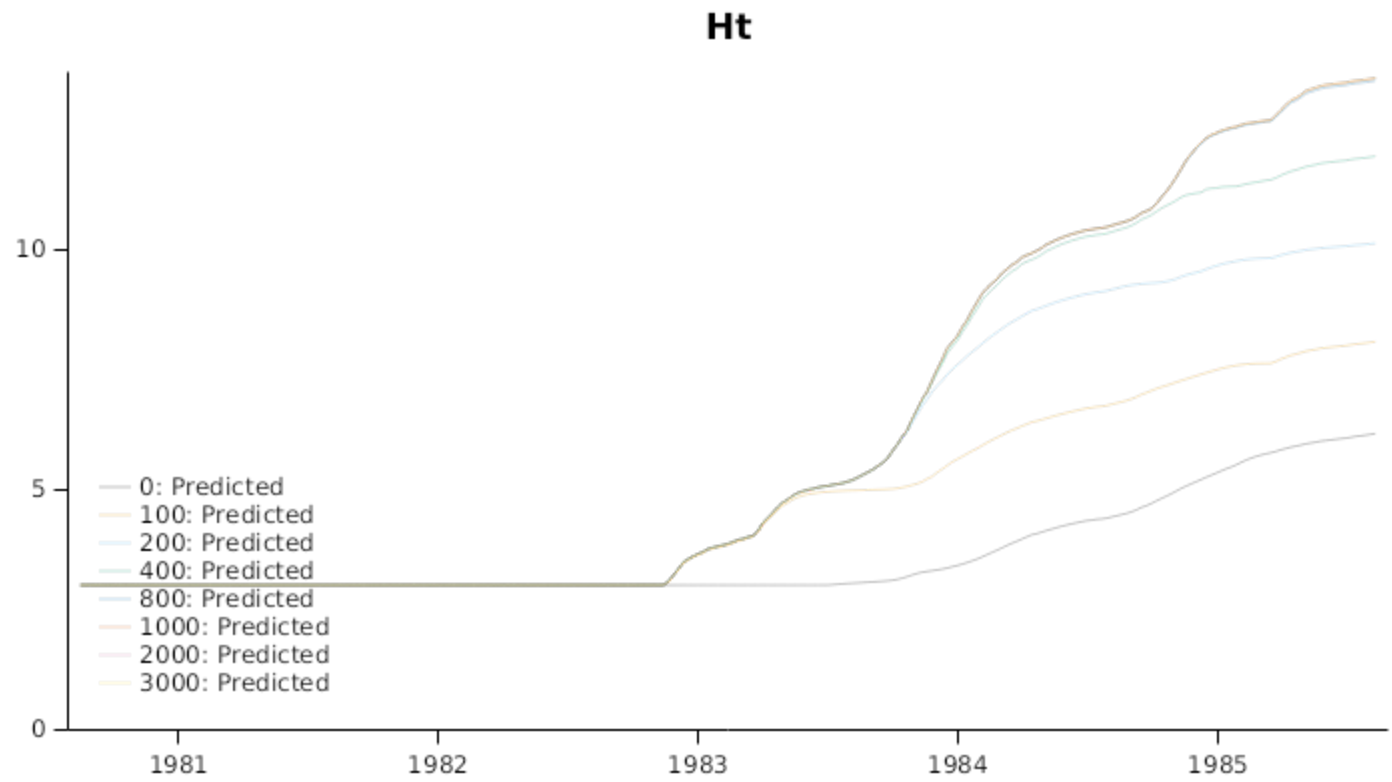
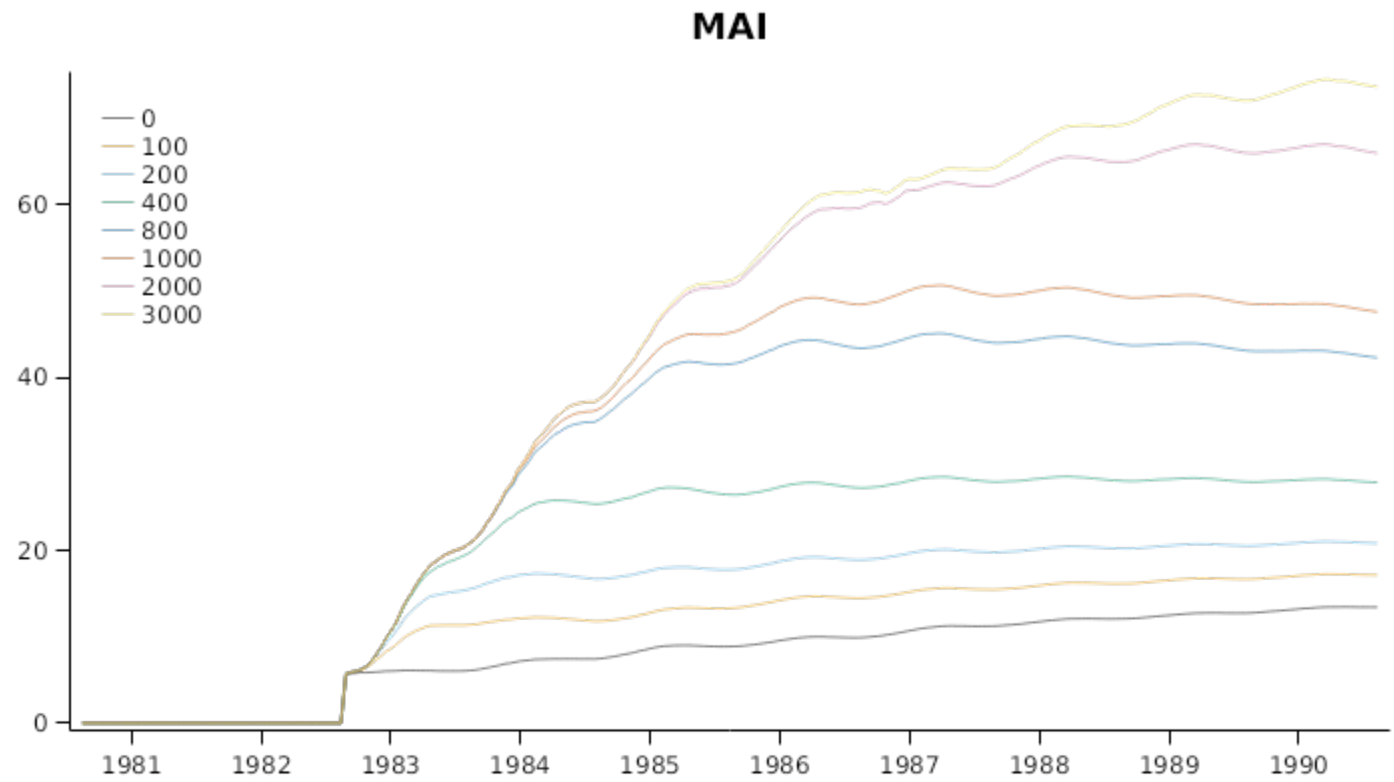
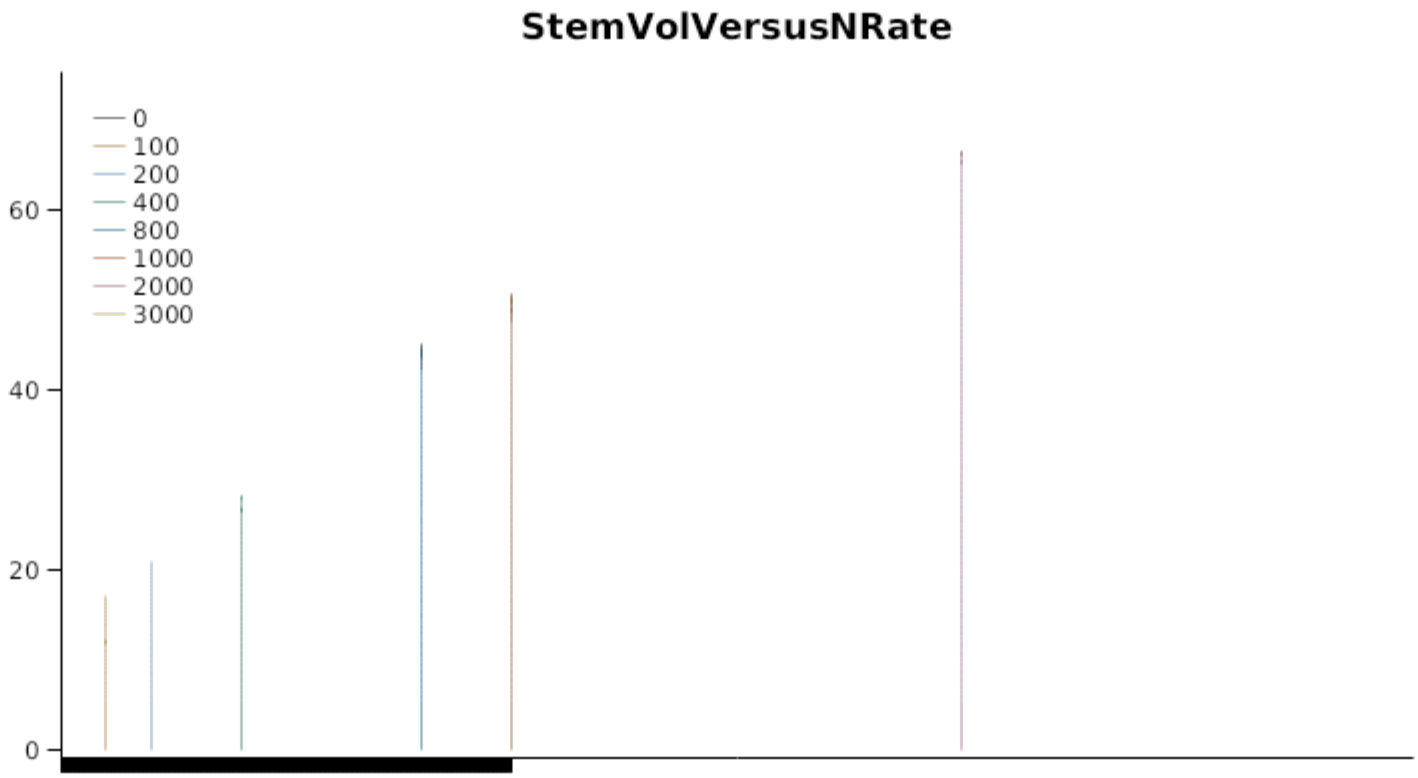
0
1981
1982
1983
1984
1985



3.4.2 Wodongal0ClimateCoffs




StemVolVersusNRate
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100
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400
800
1000
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3000
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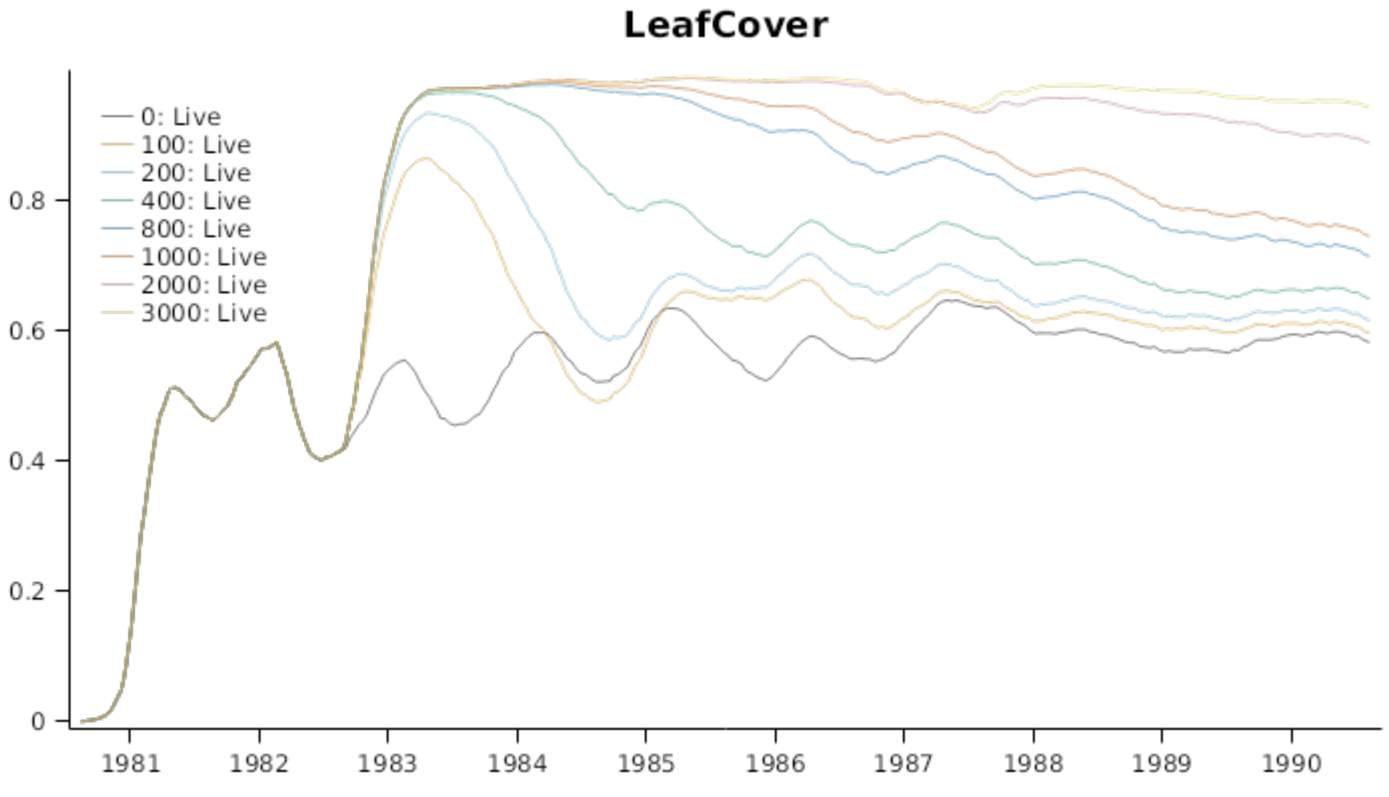
20
40
60


LeafCover
0: Live
100: Live
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800: Live
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0.4
0.6
0.8
1981
1982
1983
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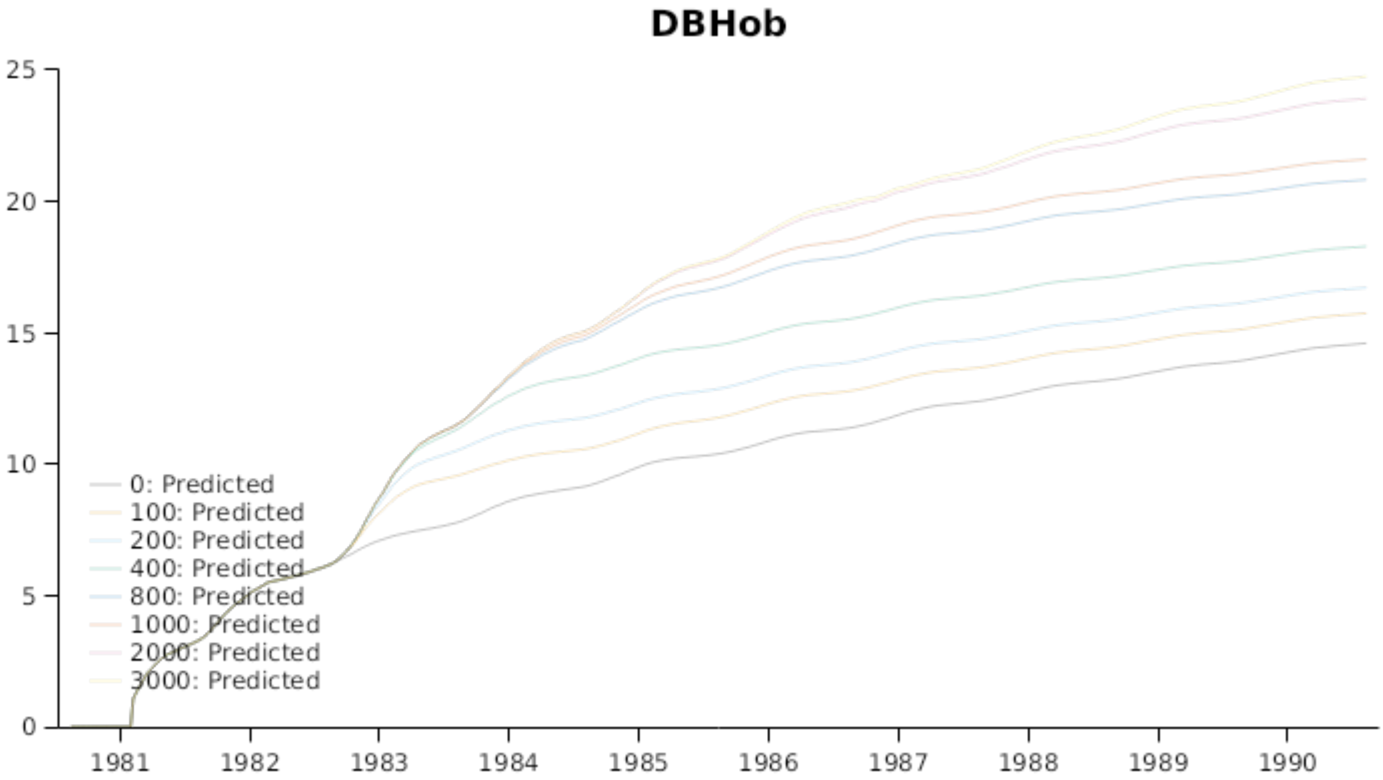
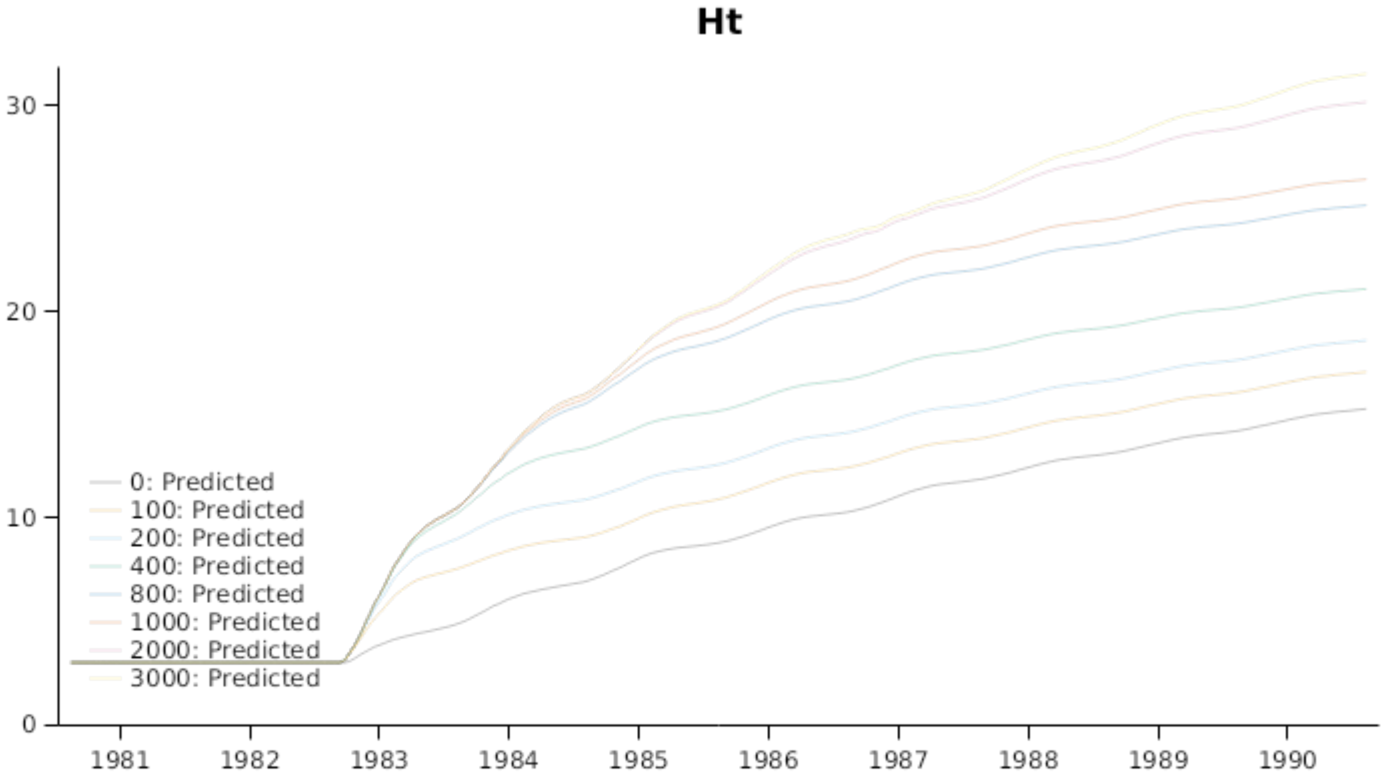
1987
1988
1989
1990



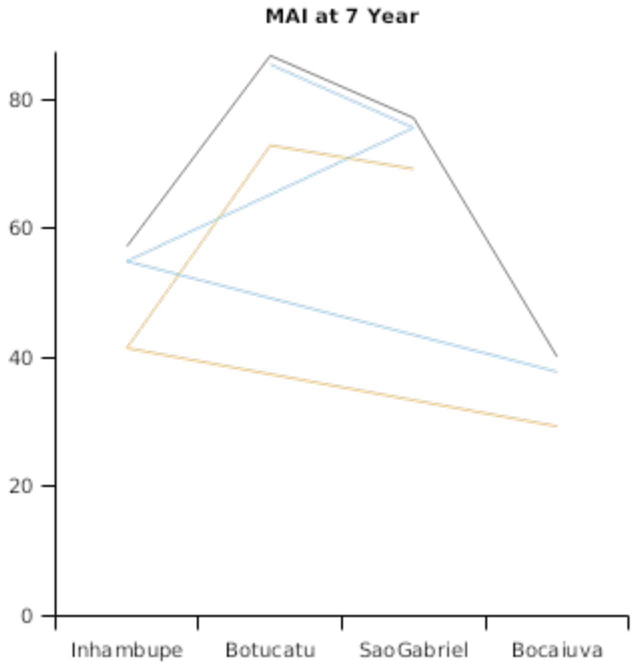


3.5 GXE Brazil

The graphs shown here demosntrate a genotypeXsite interaction. Inhambupe is a dry site in NE Brazil. Botucatu is a highly productive site in SE Brazil. Sao Gabriel is a wet site in S Brazil. Bocaiuve is dry site in SE Brazil.

List of experiments.

Experiment Name	Design (Number of Treatments)
GxEBrazil	Site x Clone (12)



3.6 ScottRiverNResponse

This experiment is described in Cromer et al., 1993 and Cromer et al., 1993. Some soil input data are from Ross, 1991. Experimental treatments were factorial combinations of two levels each of irrigation and fertilisation applied to *E. grandis.* Most growth response was to fertiliser, which included NPK, but only N is simulated, which assumes that other nutrients were present at adequate levels.

List of experiments.

Experiment Name	Design (Number of Treatments)
ScottRiverNResponse	N (7)

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