mvOZCOT component description document

This document describes the Myall Vale cotton component based on the OZCOT model.

## 1. Purpose of Component

The mvOZCOT component encapsulates the OZCOT cotton crop model developed by A.B. Hearn (published as ‘OZCOT: A Simulation Model for Cotton Crop Management’, Agricultural Systems, 1993). Subsequent enhancements and refinements have been included over subsequent years. The model was redeveloped as a component under the CSIRO Plant Industry framework for the Common Modeling Protocol in 2009.

## 2. Initialisation Properties

The initialisation property set is nearly completely optional with preset default values used in the absence of user input.

The intent is to allow the user to specify a minimal information set, as well as having the option of a maximally detailed initialisation.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Req’d** | **Default** | **Description** |
| crop\_type | string | - | No | Cotton | Type of crop to be reported to other components |
| row\_spacing\_default | double | m | No | 1 | Default basis of row spacing |
| skiprow\_default | integer1 | - | No | 0 | SkipRow basis (-1: ;0:none;1:single skip;2:double skip) |
| leaf\_res\_n\_conc | double | - | Yes | 1.0 | Nitrogen content of leaf residues |
| hucut | double | oC | Yes | 40.0 | Max temperature after which Heat Units no longer continue to increase |
| baset | double | oC | Yes | 12.0 | Min temperature as a base for temperature calculations |
| ul1 | double | - | No | 1.4 | Limit for stage 1 ES - DaRosa 1983 (0.0 – 10.0) (NOT USED) |
| cona | double | - | No | 0.35 | ES rate in stage 2 - DaRosa 1983 (0.0 – 1.0) (NOT USED) |
| open\_def | double | % | Yes | 60.0 | % Open Bolls to initiate defoliation sprays |
| a\_root\_leaf | double | - | Yes | 1.01 | Allometric constant root:leaf Huxley 1964 (0.0 – 10.0) |
| a\_stem\_leaf | double | - | Yes | 1.25 | Allometric constant stem:leaf Huxley 1964 (0.0 – 10.0) |
| e\_par | double | g/MJ | Yes | 2.5 | Photosynthesis value (turns intercepted PAR into assimilate) (0.0 – 10.0) |
| specific\_lw | double | g/m2 | Yes | 58.0 | Leaf weight demand per LAI GAC 71/72 (0.0 – 100.0) (??) |
| t\_opt | double | oC | Yes | 25.0 | Temperature scalar for Dry Matter production GAC 1981 (0.0 – 50.0) |
| t\_base | double | oC | Yes | 8.0 | Temperature scalar for Dry Matter production GAC 1981 (0.0 – 20.0) |
| wt\_area\_max | double | - | Yes | 150.0 | Leaf weight/area ratio maximum Hesketh & Low 1968 (0.0 – 400.0) |
| embryo | double | g | Yes | 0.75 | Dry weight of seedling at emergence (0.0 – 2.0) |
| f\_leaf | double | - | Yes | 0.6 | Proportion of Leaf Dry Wt at emergence (0.0 – 1.0) |
| f\_stem | double | - | Yes | 0.15 | Proportion of Stem Dry Wt at emergence (0.0 – 1.0) |
| f\_root | double | - | Yes | 0.25 | Proportion of Root Dry Wt at emergence (0.0 – 1.0) |
| elevation\_default | double | m | Yes | 200 | Default elevation of the crop site (-100.0 – 1000.0) |
| wlog\_assimilate\_red | double | - | Yes | 0.2 | Assimilate production (proportion) under waterlogging (0.0 – 1.0)  Hearn & Constable 1984 (eqn 4) |
| wlog\_carcap\_red | double | - | Yes | 0.2 | Waterlogging reduction to Carrying Capacity (0.0 – 1.0) |
| watlog\_c | double | - | Yes | 0.87 | SMI value above which waterlogging reduces carry capacity C (0.0 – 1.0) |
| watlog\_n | double | - | Yes | 0.87 | SMI value above which waterlogging reduces available N (0.0 – 1.0) |
| wlog\_carcap\_red\_stress | double | - | Yes | 0.01 | Reduction in CarryCapC with waterlogging after stress (0.0 – 1.0) |
| smi\_affect\_wlog | double | - | Yes | 0.75 | SMI value at which waterlogging will induce stress (0.0 – 1.0) |
| days\_relief\_wlog | integer1 | days | Yes | 7 | Number of days of stress relief after which has no effect on waterlogging (0 – 28) |
| frost\_kill\_immediate | double | oC | Yes | 2.0 | Temperature that will result in immediate termination of the crop (-5 – 5) |
| rtdep\_max | double | cm | No | 130.0 | (0.0 – 1000.0) (NOT USED) |
| harvest\_n\_frac | double | - | Yes | 0.85 | Fraction of uptake n for potential n harvested (0.0 – 1.0) |
| cutout\_smi\_crit | double | - | No | 0.75 | (0.0 – 1.0) (NOT USED) |
| cutout\_smi\_days | integer1 | days | Yes | 5 | Number of days cutout caused by water stress before fruiting sites become inactive (0 – 10) |
| cutout\_smi\_site\_red | double | - | Yes | 0.1 | Rate of site reduction due to SMI stress (0.0 – 1.0) |
| epcoef1 | double | - | Yes | 3.051 | Soil Water extraction coefficient (EP) SMI >= crit smi (0.0 – 10.0) |
| epcoef2 | double | - | Yes | 2.436 | Soil Water extraction coefficient (EP) SMI < crit smi (0.0 – 10.0) |
| epcoef\_smi\_crit | double | - | Yes | 0.5 | SMI value at which extraction coefficient changes |
| fbwstr\_low | double | - | Yes | 0.0 | Fruit/boll water stress – min range (0.0 – 10.0) |
| fbwstr\_high | double | - | Yes | 0.5 | Fruit/boll water stress – max range (0.0 – 10.0) |
| fbwstr\_a | double | - | Yes | 1.0 | Fruit/boll water stress – amplification factor (0.0 – 10.0) |
| fbnstr\_low | double | - | Yes | 0.0 | Fruit/boll nitrogen stress – min range (0.0 – 10.0) |
| fbnstr\_high | double | - | Yes | 0.5 | Fruit/boll nitrogen stress – max range (0.0 – 10.0) |
| fbnstr\_a | double | - | Yes | 1.0 | Fruit/boll nitrogen stress – amplification factor (0.0 – 10.0) |
| relp\_smi\_crit | double | - | Yes | 0.5 | Critical SMI level below which photosynthesis is affected (0.0 – 1.0) |
| relp\_intercept | double | - | Yes | 0.25 | Intercept of SMI vs photosynthesis equation (-1.0 – 10.0) |
| relp\_slope | double | - | Yes | 0.864 | Slope of SMI vs photosynthesis relationship (-1.0 – 10.0) |
| relp\_low | double | - | Yes | 0.0 | Photosynthetic water stress – min range (0.0 – 10.0) |
| relp\_high | double | - | Yes | 0.5 | Photosynthetic water stress – max range (0.0 – 10.0) |
| relp\_a | double | - | Yes | 1.0 | Photosynthetic water stress – amplification factor (0.0 – 10.0) |
| vsnstr\_low | double | - | Yes | 0.0 | Vegetative nitrogen stress – min range (0.0 – 10.0) |
| vsnstr\_high | double | - | Yes | 0.9 | Vegetative nitrogen stress – max range (0.0 – 10.0) |
| vsnstr\_a | double | - | Yes | 1.0 | Vegetative nitrogen stress – amplification factor (0.0 – 10.0) |
| flfsmi\_low | double | - | No | 0.0 | Water stress on pre-squaring LAI – min range (0.0 – 10.0) (NOT USED) |
| flfsmi\_high | double | - | No | 0.5 | Water stress on pre-squaring LAI – max range (0.0 – 10.0) (NOT USED) |
| flfsmi\_a | double | - | No | 1.0 | Water stress on pre-squaring LAI – amplification factor (0.0 – 10.0) (NOT USED) |
| vlnstr\_low | double | - | Yes | 0.0 | Vegetative nitrogen stress effect on LAI – min range (0.0 – 10.0) |
| vlnstr\_high | double | - | Yes | 0.9 | Vegetative nitrogen stress effect on LAI – max range (0.0 – 10.0) |
| vlnstr\_a | double | - | Yes | 1.0 | Vegetative nitrogen stress effect on LAI – amplification factor (0.0 – 10.0) |
| fw\_low | double | - | Yes | 0.0 | Water Stress effect on leaf senescence– min range (0.0 – 10.0) |
| fw\_high | double | - | Yes | 0.25 | Water Stress effect on leaf senescence– max range (0.0 – 10.0) |
| fw\_a | double | - | Yes | 1.0 | Water Stress effect on leaf senescence– amplification factor (0.0 – 10.0) |
| adjust\_low | double | - | Yes | 0.0 | Supply/Demand stress for dry matter production – min range (0.0 – 10.0) |
| adjust\_high | double | - | Yes | 5.0 | Supply/Demand stress for dry matter production – max range (0.0 – 10.0) |
| adjust\_a | double | - | Yes | 1.0 | Supply/Demand stress for dry matter production – amplification factor (0.0 – 10.0) |
| fwstrs\_low | double | - | Yes | 0.0 | Water Stress effect on boll dry matter accumulation– min range (0.0 – 10.0) |
| fwstrs\_high | double | - | Yes | 0.5 | Water Stress effect on boll dry matter accumulation – max range (0.0 – 10.0) |
| fwstrs\_a | double | - | Yes | 4.0 | Water Stress effect on boll dry matter accumulation – amplification factor (0.0 – 10.0) |
| smi\_delay\_crit | double | - | Yes | 0.25 | SMI critical level that will delay squaring (0.0 – 1.0) |
| cold\_shock\_delay\_crit | double | oC | Yes | 11.0 | Critical min temp below which physiological development will be delayed (0.0 – 20.0) |
| cold\_shock\_delay | double | dd | Yes | 5.2 | Developmental delay in DayDegrees resulting from a single occurrence of cold shock (0.0 – 20.0) |
| fert\_crit | double | kg/ha | Yes | 1.0 | Change in NO3 that will be interpreted as a fertiliser application (0.0 – 100.0) (?) |
| fert\_detect | double | kg/ha | Yes | 10.0 | Change amount in Total N that will be detected as a fertiliser application (0.0 – 100.0) (?) |
| days\_since\_fert\_max | integer1 | days | Yes | 100 | Number of days since a fertiliser event detected before N totals will be reset to zero (0 – 100) (?) |
| ll | double[] | mm/mm | No | ? | LowerLimit for crop extraction by soil layer (giving unavailable soil water for the crop). LL15 read from the soil water component if not supplied as part of the crop parameters |
| cultivar | string | - | No | - | Name of the cotton cultivar. If not specified, ALL varietal details must be specified |
| sow\_depth | double | mm | Yes | 50 | Depth of sown seed (0.0 – 100.0) |
| row\_spacing | double | m | Yes | 1.0 | Spacing of the sown crop rows (0.1 – 5.0) |
| plants\_per\_m\_row | double | - | No | 10.0 | Planting density of seed per metre of row (1.0 – 100.0) (NOT USED) |
| skiprow | integer1 | - | Yes | 0 | Flag to indicate 0:solid planting, 1:single skip, 2:double skip |
| percent\_l | double | % | Yes | 42.0 | Percentage Lint in boll yield by weight (30.0 – 55.0) |
| scboll | double | g | Yes | 4.7 | Wt Seed Cotton per boll (1.0 – 8.0) |
| respcon | double | - | Yes | 0.01593 | Respiration constant (0.001 – 0.030) |
| sqcon | double | - | Yes | 0.0217 | Squaring constant for generating sites per dd (0.001 – 0.030) |
| fcutout | double | - | Yes | 0.5411 | Constant used to determine when site production stops due to boll load (0.0 – 1.0) |
| flai | double | - | Yes | 0.52 | Varietal adjustment for rate of LAI gain per fruiting site (0.0 – 1.0) |
| ddisq | double | - | Yes | 402.0 | DayDegrees (dd) accumulation to first square |
| popcon | double | - | Yes | 0.03633 | Plant population constant for adjustment of daily site production (0.0 – 1.0) |
| acotyl | double | mm2 | Yes | 525.0 | Leaf area of cotyledons (0.0 – 1000.0) |
| rlai | double | - | Yes | 0.010 | Base rate of leaf growth pre first square (0.0 – 1.0) |
| fburr | double | - | Yes | 1.23 | Proportional boll weight with Burr Fraction included (0.0 – 5.0) |
| dlds\_max | double | - | Yes | 0.12 | Max leaf area increase per site (0.0 – 5.0) |
| rate\_emergence | double | mm/dd | Yes | 1.0 | Growth rate (mm per day) from sowing to emergence (0.0 – 10.0) |
| frudd | double[] | dd | Yes | - | Array of values of cumulative DayDegrees for each growth phase of fruit development (8 categories) |
| bltme | double[] | - | Yes | - | Thermal time for fruit categories as a proportion of the total required to develop a complete boll (categories 4 – 8) |
| wt | double[] | - | Yes | - | Relative weight of each category relative to a mature (inedible) green boll (cat 7). |

## 3. Subscribed Events – Sequenced

### 3.1. do\_cotton\_growth

AusFarm default sequencing: 6000 (?)

Computes the growth in the cotton crop model for the time step.

### 3.2. tick

AusFarm Default sequencing: 1000 (?)

Allows the cotton crop model to validate that weather details match time step details and to ‘count’ days (for DAS, DOY, etc) for date arithmetic.

## 4. Subscribed Events – Other

### 4.1. do\_cotton\_sow

Causes the cotton crop model to initiate and ‘sow’ a new cotton crop.

### 4.2. do\_cotton\_harvest

Causes the cotton crop model to harvest a cotton crop, calculate yield and terminate the crop.

### 4.3. reset\_cotton

Causes the cotton crop model to reset internal variables ready to initiate a new crop.

## 5. Published Events

None.

?? Future development should include events such as ‘Crop Mature’ so that management decisions can be removed from model logic and left to a manager module to handle appropriately.

## 6. Driving properties

### 6.1. Climate drivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Event:State** | **Number\*** | **Description** |
| maxt | double | oC | do\_cotton\_growth:1 | 1 | Maximum air temperature |
| mint | double | oC | do\_cotton\_growth:1 | 1 | Minimum air temperature |
| radn | double | MJ/m2 | do\_cotton\_growth:1 | 1 | Daily solar radiation |
| rain | double | mm | do\_cotton\_growth:1 | 1 | Daily rainfall |

### 6.2. Soil Water drivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Event:State** | **Number\*** | **Description** |
| dlayer | double[] | mm | do\_cotton\_growth:1 | 1 | Soil layer depth profile |
| bd | double[] | g/cm3 | do\_cotton\_growth:1 | 1 | Soil bulk density profile |
| ll15 | double[] | mm/mm | do\_cotton\_growth:1 | 1 | Lower limit 15 bars Soil water profile |
| dul | double[] | mm/mm | do\_cotton\_growth:1 | 1 | Drained Upper Limit Soil water profile |
| sat | double[] | mm/mm | do\_cotton\_growth:1 | 1 | Saturation point for Soil water profile |
| sw | double[] | mm/mm | do\_cotton\_growth:1 | 1 | Soil Water profile – current |
| es | double | mm | do\_cotton\_growth:1 | 1 | Soil evaporation |
| runoff | double | mm | do\_cotton\_growth:1 | 1 | runoff as a result of a rain event. Water does not enter profile |

### 6.3. Soil Nitrogen drivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Event:State** | **Number\*** | **Description** |
| no3\_min | double | kg/ha | do\_cotton\_growth:1 | 1 | Soil nitrate minimum |
| no3 | double | kg/ha | do\_cotton\_growth:1 | 1 | Soil nitrate – current |
| nh4\_min | double | kg/ha | do\_cotton\_growth:1 | 1 | Soil ammonium minimum |
| nh4 | double | kg/ha | do\_cotton\_growth:1 | 1 | Soil ammonium – current |
| urea | double | kg/ha | do\_cotton\_growth:1 | 1 | Soil urea |

\* “Number” refers to the number of sources for the driving variable that is permitted.

## 7. Owned properties

All initialisation properties are readable. In addition, the following owned properties are available:

(a) Standard properties

|  |  |  |  |
| --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Description** |
| name | string |  | mvOZCOT |
| type | string |  | Value is “mvOZCOT model” |
| version | string |  | Value is “2.0” |
| author | string |  | Value is “CSIRO Plant Industry – Cotton Research” |
| active | Boolean |  | Denotes whether or not the component is active |
| state | string |  | SDML description of the current state |

(b) Component-specific properties

|  |  |  |  |
| --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Description** |
| n/a |  |  |  |

## 7. Setter properties

These are properties owned by other components that this component directly attempts to update via a *requestSetValue* message.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Property** | **Type** | **Units** | **Owning**  **Component** | **Description** |
| dlt\_sw\_dep | double[] | mm | APSRU.SoilWat2 | Change in soil water by layer |
| dlt\_no3 | double[] | kg/ha | APSRU.SoilN | Change in soil nitrate by layer |