The model

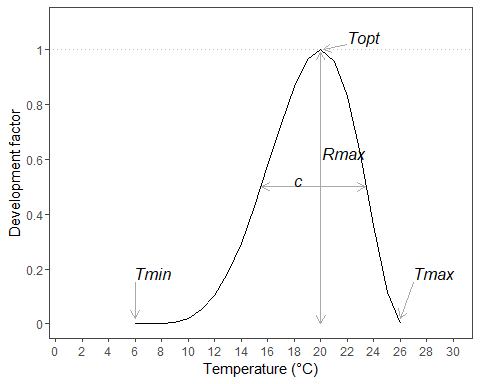
Mladen Cucak

03 February, 2020

## [1] "All packages were successfully loaded."

## Beta function

## Warning: Removed 4 rows containing missing values (geom\_path).  
  
## Warning: Removed 4 rows containing missing values (geom\_path).



## The Model

### Sporulation

Ther eis a fair reason to believe that the sporlation is mostly local, and that the spore survival reduces according to power law function

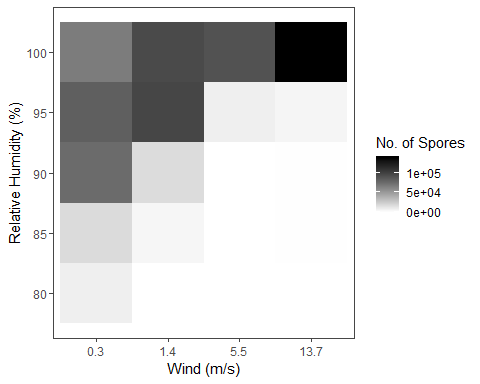
The reason for not having a fixed threshold for estimation of leaf wetness using rh is the same as for having the sporulation segment in the first place. Also this is a regional model. No real data on leaf wetness estimationband the analysis have shown that setting the threshold too low is bringing in question the usefulness of the model. so we will use the adapted threshold…. When the rh is above 95 at the station provides more certain reason to estimate that risk of the host plant surface is wet and susceptible to infection. Use michelaidis and nestad write-up of the model Read the model by Israeli people The model is based on estimation of three segments of the life cycle: - Sporulation risk  
- Survial of inoculum and  
- Infection risk  
Potato late blight risk is the calculated based on cumulatiove daily estiations of risk. To accomodate the simplicity

Sporulation is occuring and whether those spores that are produced will be dispersed in the air and we want to know if those sporangia are transported viable or are killed during transport. Solar radiation is lethal to sporangia and most that are in the air will be killed by the sunlight before they reach another location, and subsequentially, how long they might survive on foliage in that location. We do know that on sunny days they don’t survive as well as they do on cloudy days so conceptually we know that the very worst conditions for dispersal ae a sunny morning so that does enhanced release becomes cloudy fairly quickly and midday and that will enhance survival of spores. Wet leaves at night are enabling germination and infection to occur during the night. These factors are put together into an algorithm which includes the amount of sporulation, the survival of this branch and the likelihood that germination will occur on the succeeding evening.This algorithm then provides a Risk estimation.

The risk of spurulation and infection is calculated as a function of temperature and relative humidity, where relative humidity is an estimator of surface wetness. The impact of temperature on sporulation and infection risk was modeled using five parameter beta function, after Yan and Hunt (1996). To parameterize the model, cardinal (minimum (Tmin), maximum (Tmax) and optimal (Topt)) temperatures (CT) for were extracted from the literature. Crosier (1934) found that no sporangia was formed outside the range 3-26°C while the optimum was considered to be between 18 and 22°C. The shape factor was calculated

Rao et al. (1998) showed that LWD estimation on a maze ear was less accurate with weather data measured nearby weather station than near the top of the maze canopy. When estimated weather data are used as input data of an energy balance model, it is considerably difficult for energy balance models to correctly identify wetness occurrence.

## New names:  
## \* `` -> ...1

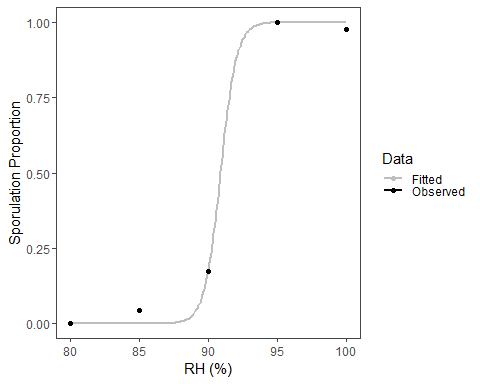


*!!The rate parameter is not good here and this needs refitting*

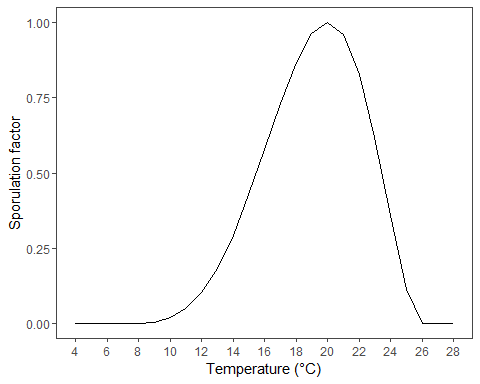
## Nonlinear regression model  
## model: spor ~ K \* n0 \* exp(r \* rh)/(K + n0 \* (exp(r \* rh) - 1))  
## data: parent.frame()  
## K n0 r   
## 9.705e+04 6.049e-04 1.735e+00   
## residual sum-of-squares: 22310121  
##   
## Number of iterations till stop: 94   
## Achieved convergence tolerance: 1.49e-08  
## Reason stopped: Number of calls to `fcn' has reached or exceeded `maxfev' == 400.

## # A tibble: 5 x 2  
## spor .fitted  
## <dbl> <dbl>  
## 1 69 0.000605  
## 2 4384 3.54   
## 3 17147 17073.   
## 4 98221 96972.   
## 5 95804 97050.

## [1] 6.232801e-09 7.413616e-09 8.818138e-09 1.048875e-08 1.247586e-08  
## [6] 1.483943e-08 1.765079e-08 2.099476e-08 2.497225e-08 2.970328e-08  
## [11] 3.533062e-08 4.202406e-08 4.998559e-08 5.945544e-08 7.071937e-08  
## [16] 8.411726e-08 1.000534e-07 1.190087e-07 1.415551e-07 1.683729e-07  
## [21] 2.002715e-07 2.382132e-07 2.833431e-07 3.370229e-07 4.008724e-07  
## [26] 4.768183e-07 5.671522e-07 6.746001e-07 8.024041e-07 9.544207e-07  
## [31] 1.135237e-06 1.350309e-06 1.606127e-06 1.910410e-06 2.272340e-06  
## [36] 2.702837e-06 3.214892e-06 3.823956e-06 4.548408e-06 5.410107e-06  
## [41] 6.435054e-06 7.654176e-06 9.104259e-06 1.082906e-05 1.288061e-05  
## [46] 1.532083e-05 1.822333e-05 2.167570e-05 2.578209e-05 3.066640e-05  
## [51] 3.647599e-05 4.338612e-05 5.160527e-05 6.138138e-05 7.300933e-05  
## [56] 8.683987e-05 1.032901e-04 1.228562e-04 1.461281e-04 1.738075e-04  
## [61] 2.067288e-04 2.458843e-04 2.924539e-04 3.478405e-04 4.137121e-04  
## [66] 4.920520e-04 5.852175e-04 6.960108e-04 8.277620e-04 9.844286e-04  
## [71] 1.170712e-03 1.392196e-03 1.655514e-03 1.968536e-03 2.340605e-03  
## [76] 2.782803e-03 3.308265e-03 3.932557e-03 4.674104e-03 5.554702e-03  
## [81] 6.600104e-03 7.840700e-03 9.312301e-03 1.105702e-02 1.312430e-02  
## [86] 1.557201e-02 1.846767e-02 2.188981e-02 2.592934e-02 3.069093e-02  
## [91] 3.629435e-02 4.287556e-02 5.058749e-02 5.960017e-02 7.010000e-02  
## [96] 8.228773e-02 9.637483e-02 1.125777e-01 1.311094e-01 1.521686e-01  
## [101] 1.759256e-01 2.025056e-01 2.319710e-01 2.643029e-01 2.993845e-01  
## [106] 3.369898e-01 3.767783e-01 4.183007e-01 4.610141e-01 5.043078e-01  
## [111] 5.475370e-01 5.900607e-01 6.312793e-01 6.706665e-01 7.077939e-01  
## [116] 7.423437e-01 7.741122e-01 8.030031e-01 8.290151e-01 8.522245e-01  
## [121] 8.727669e-01 8.908196e-01 9.065850e-01 9.202776e-01 9.321135e-01  
## [126] 9.423024e-01 9.510423e-01 9.585167e-01 9.648920e-01 9.703179e-01  
## [131] 9.749270e-01 9.788360e-01 9.821468e-01 9.849476e-01 9.873147e-01  
## [136] 9.893135e-01 9.910003e-01 9.924229e-01 9.936221e-01 9.946325e-01  
## [141] 9.954835e-01 9.962002e-01 9.968034e-01 9.973112e-01 9.977385e-01  
## [146] 9.980980e-01 9.984005e-01 9.986549e-01 9.988689e-01 9.990489e-01  
## [151] 9.992003e-01 9.993276e-01 9.994346e-01 9.995246e-01 9.996003e-01  
## [156] 9.996639e-01 9.997175e-01 9.997624e-01 9.998003e-01 9.998321e-01  
## [161] 9.998588e-01 9.998813e-01 9.999002e-01 9.999161e-01 9.999295e-01  
## [166] 9.999407e-01 9.999501e-01 9.999581e-01 9.999648e-01 9.999704e-01  
## [171] 9.999751e-01 9.999791e-01 9.999824e-01 9.999852e-01 9.999876e-01  
## [176] 9.999895e-01 9.999912e-01 9.999926e-01 9.999938e-01 9.999948e-01  
## [181] 9.999956e-01 9.999963e-01 9.999969e-01 9.999974e-01 9.999978e-01  
## [186] 9.999982e-01 9.999984e-01 9.999987e-01 9.999989e-01 9.999991e-01  
## [191] 9.999992e-01 9.999993e-01 9.999995e-01 9.999995e-01 9.999996e-01  
## [196] 9.999997e-01 9.999997e-01 9.999998e-01 9.999998e-01 9.999998e-01  
## [201] 9.999999e-01



Temperature relation to sporulation.

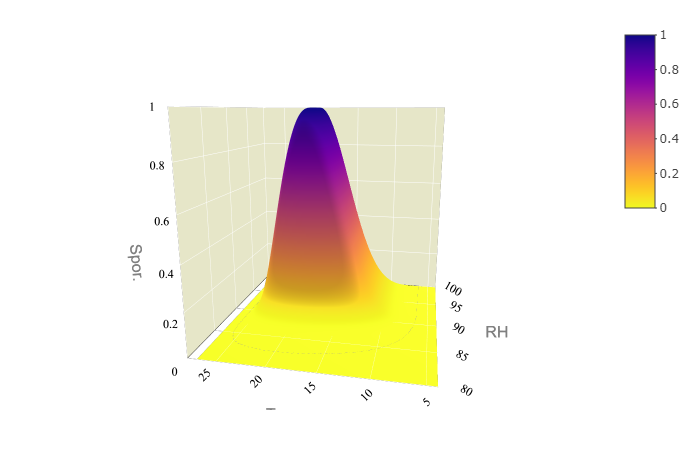


Save parameters into a separate file.  
We will also add the parameter for the sporulation threshold. It is considered that sporulation criteria is met if there was n (default 10) hours of sporulation.

This function calculates the sporulation as a product of two vectors containing hourly measurements of relative humidity and temperature.

Visualisation of the overall effect of this function.

## Loading required package: viridisLite

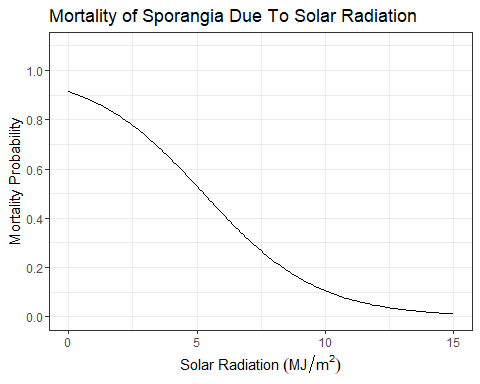


3D surface plot of sporulation function

## Survival

Airborne sporangia survival.

## Warning: Removed 150 rows containing missing values (geom\_path).  
  
## Warning: Removed 150 rows containing missing values (geom\_path).



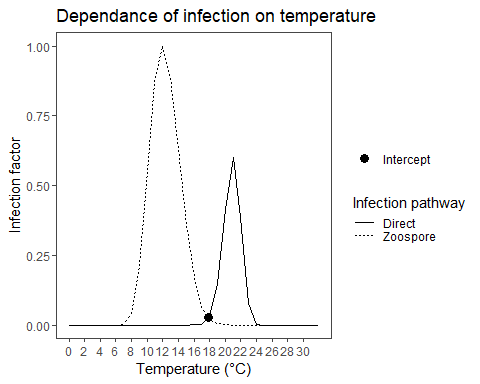
Save the parameters into a separate file.

This function calculates the survival probabllty based on sum of total daily sola radiation.

## Infection

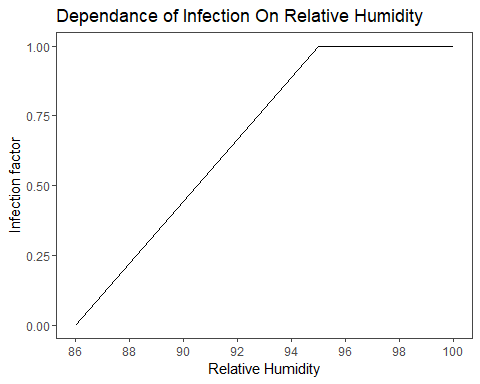
!!!!!!!!!!!!!!!!The Shape factor needs fixing for the sensitivity analysis. ! None of leaf wetness assumptions are fulfilled before the plants form a substantial haulum. The surface wethess on plant surface is an essential requirement for germination or zoospore release and for subsequent infection to take place. Risk of the infection is calculated as a function of temperature and leaf wetness risk factors.  
Temperature effect on Infection is estimated using two functions, one for the direct germinationa and one for zoospore infection. Minimum and maximum values are set equal for both functions.  
The leaf wetness is calculated using two linear functions.

## Scale for 'x' is already present. Adding another scale for 'x', which  
## will replace the existing scale.



RH factor.  
!!!!!!!!!!!Needs further clarification and explanation expecilly why this exact figure/or just do calibration.

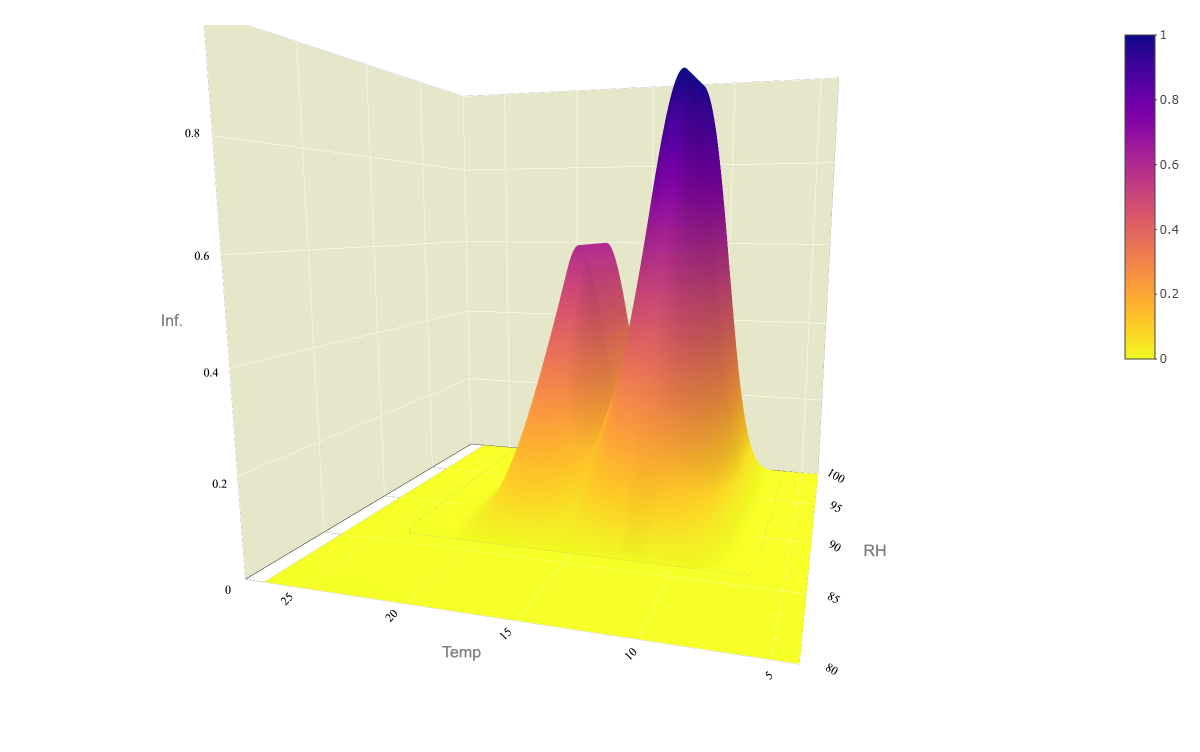
## Scale for 'x' is already present. Adding another scale for 'x', which  
## will replace the existing scale.



Save parameters into a separate file.

Here we put it all into a function. This function calculates the infection risk based on two given vectors containing hourly measurements of reltive humidity and temperature.

Visualisation of the overal effect of this function.



3D surface plot of Infection function

# Geo location

## The cmulative risk function

# Parameteres

We will store all parameteres in a single file.