EDS 230/ESM232: Assignment 4: Sensitivity Analysis

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1 Load Libraries

Often when we are estimating vegetation or crop water use we need to know the atmospheric conductance - which is essentially how easily water diffuses into the air and depends largely on windspeed (you get more evaporation in windier conditions) Atmospheric conductance is also influenced by the vegetation itself and the turbulence it creates

2 Part 1

Code a function to compute atmospheric conductance Cat (how easily vapor diffuses from vegetation surfaces)

3 Part 2

You are estimating the atmospheric conductance for a forest that is 10 m high (the accuracy of that measurement is +/- 0.5 m) Windspeeds v in this region are normally distributed with a mean of 250 cm/s with a standard deviation of 30 cm/s

```
part_2_answer <- atm_conductance(h = 10,
                                 v = 250)
```

The estimated atmospheric conductance for this forest is 15.44 Siemens per centimeter.

4 Part 3

Do a sensitivity analysis that considers the sensitivity of your estimate to uncertainty in the following parameters and inputs:

- **v** *Windspeeds v are normally distributed with a mean of 250 cm/s with a standard deviation of 30 cm/s*
- **h** *For vegetation height assume that height is somewhere between 9.5 and 10.5 m (but any value in that range is equally likely)*
- **kd**, **k0** *For the kd and k0 parameters you can assume that they are normally distributed with standard deviation of 1% of their default values*

4.1 Part 3A

Make a list of params:

```
factors <- c("h", "v", "kd", "ko")
```

Decide how many parameter sets to run:

```
nsets = 100
```

Set distributions for parameters:

```
q = c("qunif", "qnorm", "qnorm", "qnorm")
q.arg = list(list(min = 9.5, max = 10.5),
             list(mean = 250, sd = 30),
             list(mean = 0.7, sd = 0.7 * 0.01),
             list(mean = 0.1, sd = 0.1 * 0.01))
```

Generate parameter values for the 4 parameters:

```
sens_atmos_conduction = LHS(NULL,
                  factors, # list of parameters
                  nsets, # number of param sets to run
                  q, # how to make list of argumentse
                  q.arg # parameters of list of arguments
                  )
```

4.2 Part 3B

Run atmospheric conductance model with parameters:

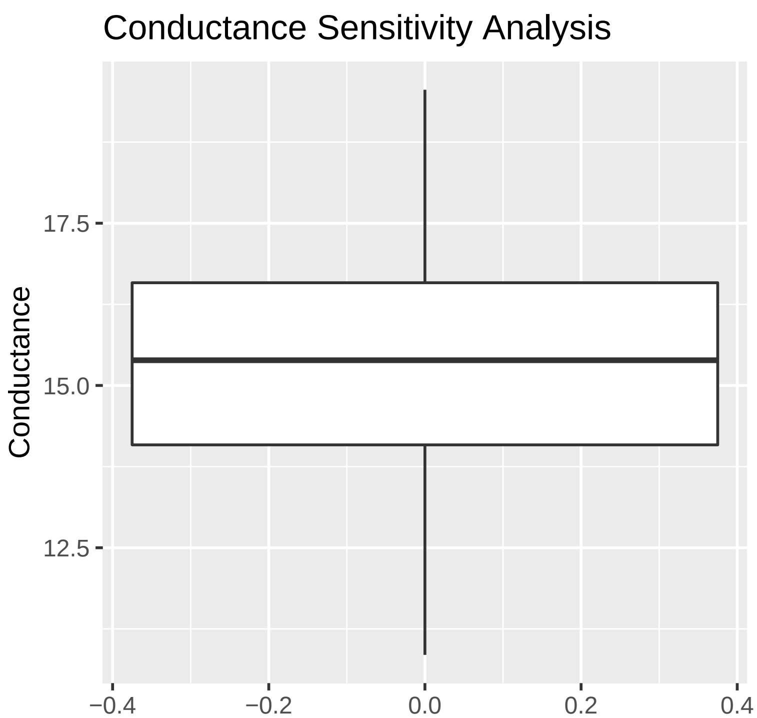
```
sensitivity_parameters <- get.data(sens_atmos_conduction)

conduction <- sensitivity_parameters %>% pmap(atm_conductance)

conduction_sd <- t(as.data.frame(conduction))
conduction_sd <- as.data.frame(conduction_sd)
names(conduction_sd) <- c("conductance")
rownames(conduction_sd) <- 1:nrow(conduction_sd)

head(conduction_sd)
```

```
##   conductance
## 1    15.04351
## 2    17.31741
## 3    15.66475
## 4    15.63231
## 5    14.00122
## 6    11.99823
```

4.3 Part 3C

Plot conductance estimates in a way that accounts for parameter uncertainty

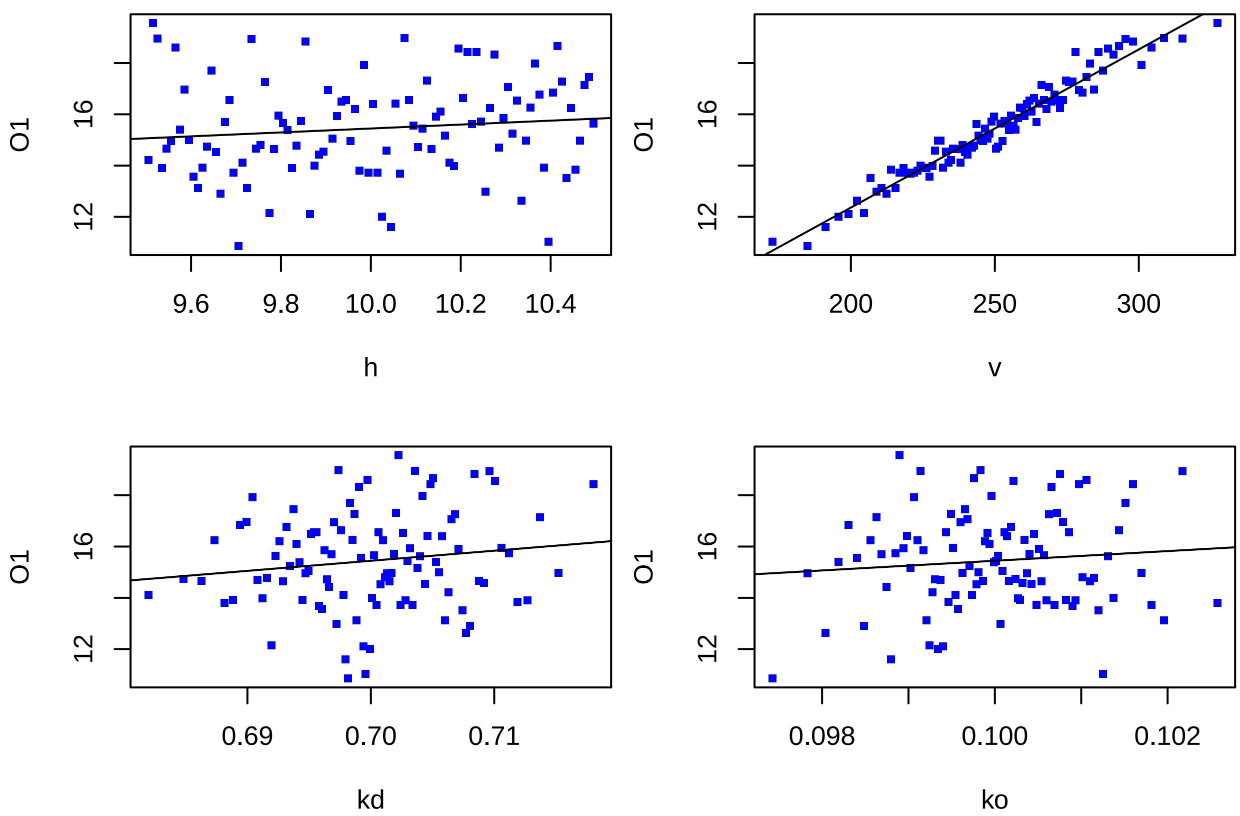
```
conduction_sd %>% ggplot(aes(y = conductance)) +
  geom_boxplot() +
  ggtitle("Conductance Sensitivity Analysis") +
  ylab("Conductance") +
  xlab("") # remove values on x axis
```



4.4 Part 3D

Plot conductance estimates against each of your parameters

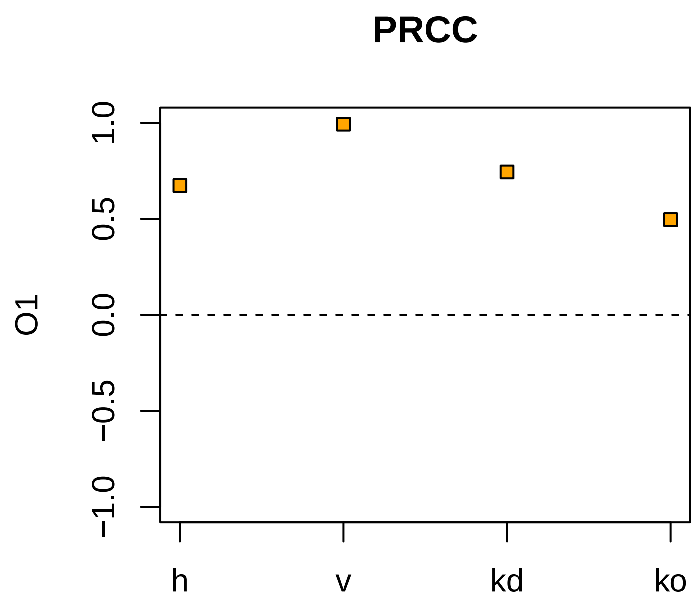
```
sens_cond <- pse::tell(sens_atmos_conduction,
                       t(as.matrix(conduction_sd)))

pse::plotscatter(sens_cond, col="blue", cex=5)
```



4.5 Part 3E

Estimate the Partial Rank Correlation Coefficients

```
pse::plotprcc(sens_cond)
```




```
sens_cond$prcc
```

```
## [[1]]
##
## Call:
## pcc.default(X = L, y = r, rank = T, nboot = nboot)
##
## Partial Rank Correlation Coefficients (PRCC):
##     original
## h  0.6739775
## v  0.9935346
## kd 0.7445789
## ko 0.4963575
```

4.6 Part 3F

Our results show that aerodynamic conductance is most sensitive to windspeed (v). Therefore you should focus on windspeed if you want to reduce uncertainty in aerodynamic conductance estimates. Because we know that climate change can impact average windspeeds, this tells us that plant water use can be sensitive to climate change.