# Classification of liana and tree leaves using VIS-NIR or LWIR reflectance

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# Liana abundance

- Since 2002, different studies have shown an increase in liana abundance.
- Detrimental effects on the ecosystems.
- These trends have cast doubt the accuracy of some productivity models.
- Detection!

http://climatenewsnetwork.net

The importance of including lianas in global vegetation models

Hans Verbeeck[a,1] and Elizabeth Kearsley[a]

2016; PNAS, 133

# Classification of lianas and trees

- **Several studies have addressed the classification at different levels**
- **Visible, near and shortwave infrared as regions of interest**
- **Long-wave infrared region?**

**Foster et al. 2008**

**Castro-Esau et al. 2004**

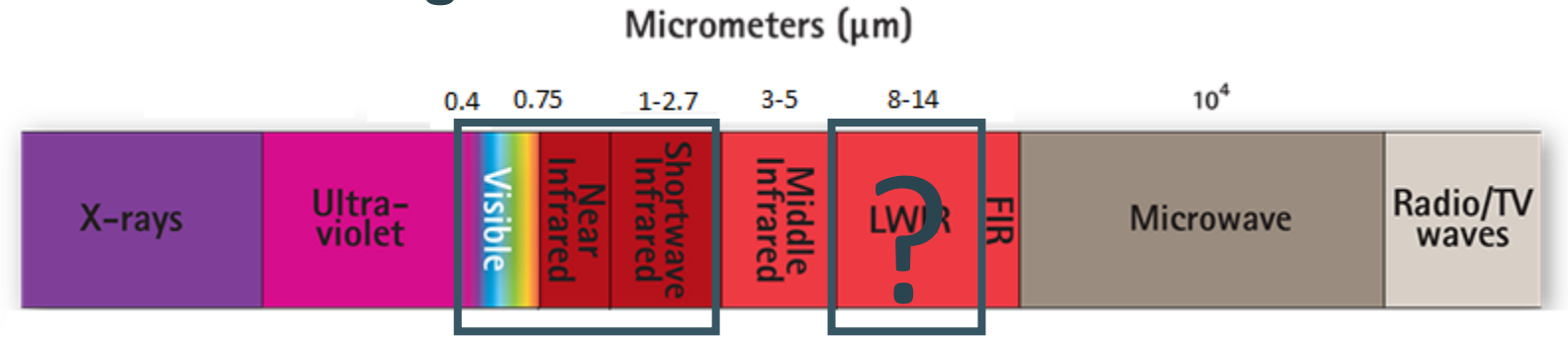
**Sánchez−Azofeifa and Castro−Esau 2006**

**Kalacska et al. 2007**

**Sánchez-Azofeifa et al. 2009**

Hesketh and Sánchez-Azofeifa 2012

**Martin et al. 2016**



# Objectives

- **To determine which spectral region could improve the discrimination of lianas and trees leaves. (VIS-NIR or LWIR)**
- **To evaluate which pre-processing approach may enhance the discrimination.**
- **To evaluate, in combination to data reduction techniques, which classifiers are the most promising to discriminate liana and tree leaves.**

# Study site and design

- **Santa Rosa National Park, Costa Rica**
- **May-July, 2017**
- **Full sun exposed leaves**
- **5 leaves per individual / 4 individuals = 20 leaves per species**

**Santa Rosa Tropical Dry Forest**

# Species selected

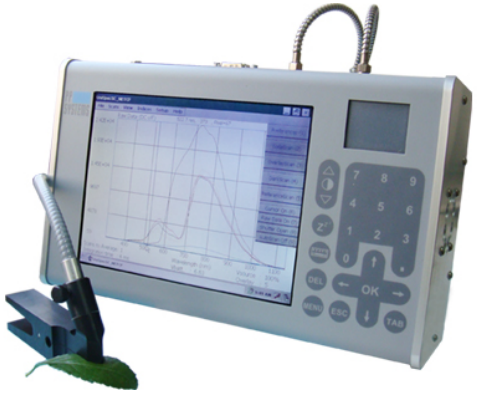
| Trees | | Lianas | |
|---|---|---|---|
| Family | Species | Family | Species |
| Apocynaceae | *Stemmadenia obovata* | Apocynaceae | *Forsteronia sp.* |
| Bignoniaceae | *Crescentia alata* | | *Forsteronia spicata* |
| Burseraceae | *Bursera simarouba* | Bignoniaceae | *Arrabidaea chica* |
| Dilleniaceae | *Curatella americana* | | *Cydista aequinoctialis* |
| Euphorbiaceae | *Jatropha curcas* | | *Cydista diversifolia* |
| | *Sapium glandulosum* | | *Paulinia sp.* |
| Fabaceae/Caes | *Bauhinia ungulata* | Cucurbitaceae | *Cayaponia racemosa* |
| | *Hymenaea courbaril* | Dilleniaceae | *Tetracera volubilis* |
| Fabaceae/Pap | *Gliricidia sepium* | Malpighiaceae | *Heteropterys panamensis* |
| Fagaceae | *Quercus oleoides* | | *Heteropterys sp.* |
| Hippocrateaceae | *Semialarium mexicanum* | | *Hiraea reclinata* |
| Lauraceae | *Ocotea veraguensis* | Rhamnaceae | *Gouania polygama* |
| Malpighiaceae | *Byrsonima crassifolia* | Sapindaceae | *Serjania atrolineata* |
| Malvaceae | *Guazuma ulmifolia* | | *Serjania schiedeana* |
| Meliaceae | *Cedrela odorata* | | |
| | *Trichilia americana* | | |
| Nyctaginaceae | *Pisonia aculeata* | | |
| Sapindaceae | *Cochlospermum vitifolium* | | |
| Simaroubaceae | *Simarouba glauca* | | |
| Tiliaceae | *Luehea speciosa* | | |
| Verbenaceae | *Rehdera trinervis* | | |

14 species of lianas / 7 families

21 species of trees / 17 families

# Data collection: spectral reflectance

## Unispec-SC

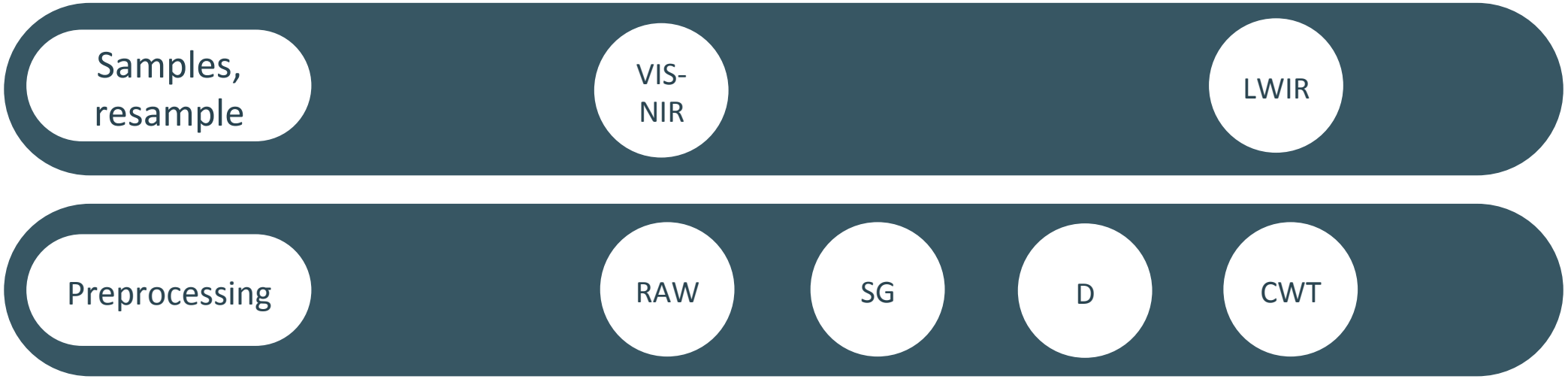


- Leaf clip and light source
- Range 0.31-1.13 μm (0.45-0.95 μm)
- Resolution 3.3 nm (1 nm resample)

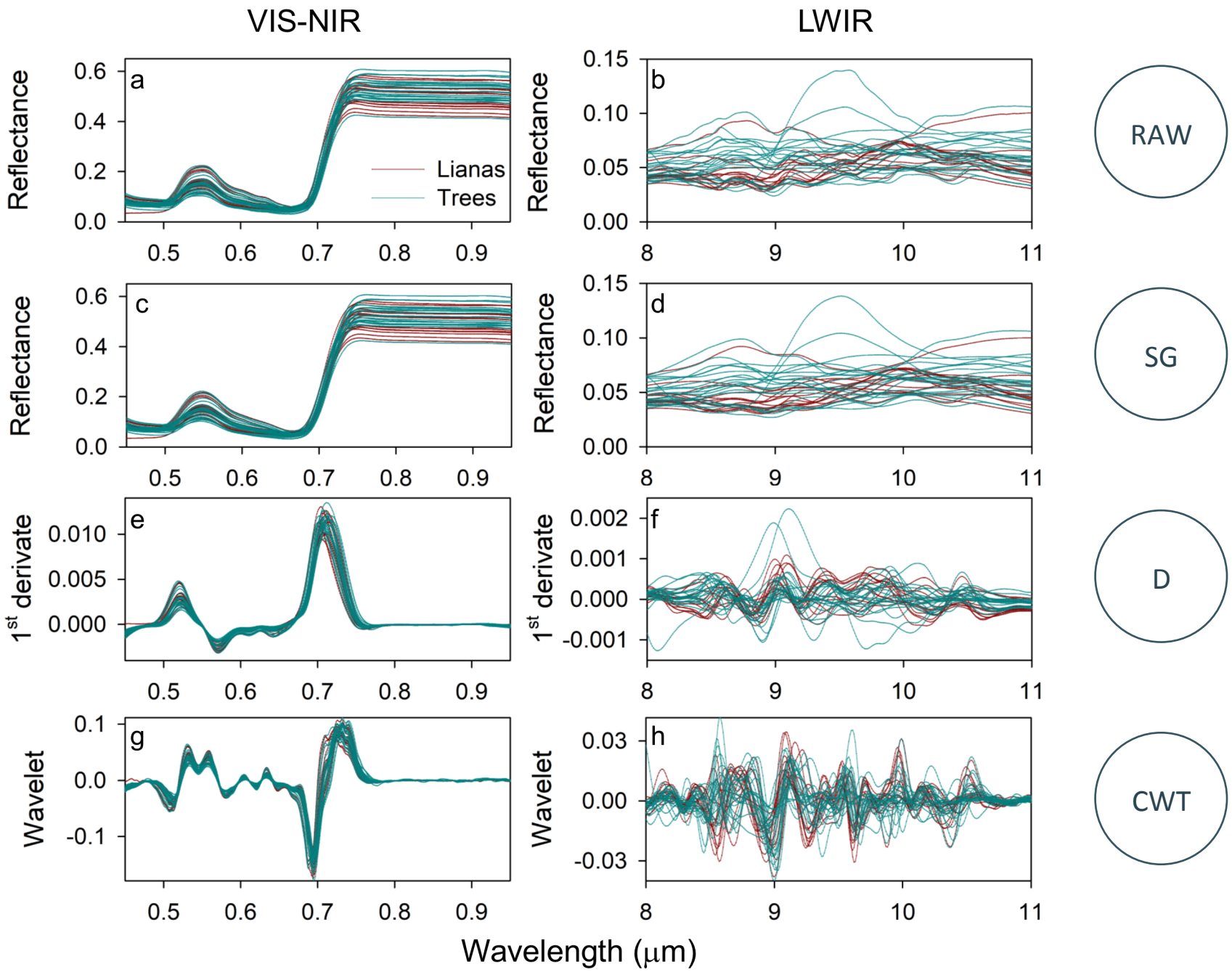
## Agilent 4100 ExoScan FTIR

- FTIR (Fourier transform infrared) spectrometer
- Range 2.5-16 μm (8-11 μm)
- Resolution 1.86 $cm^{-1}$ (10 nm resample)

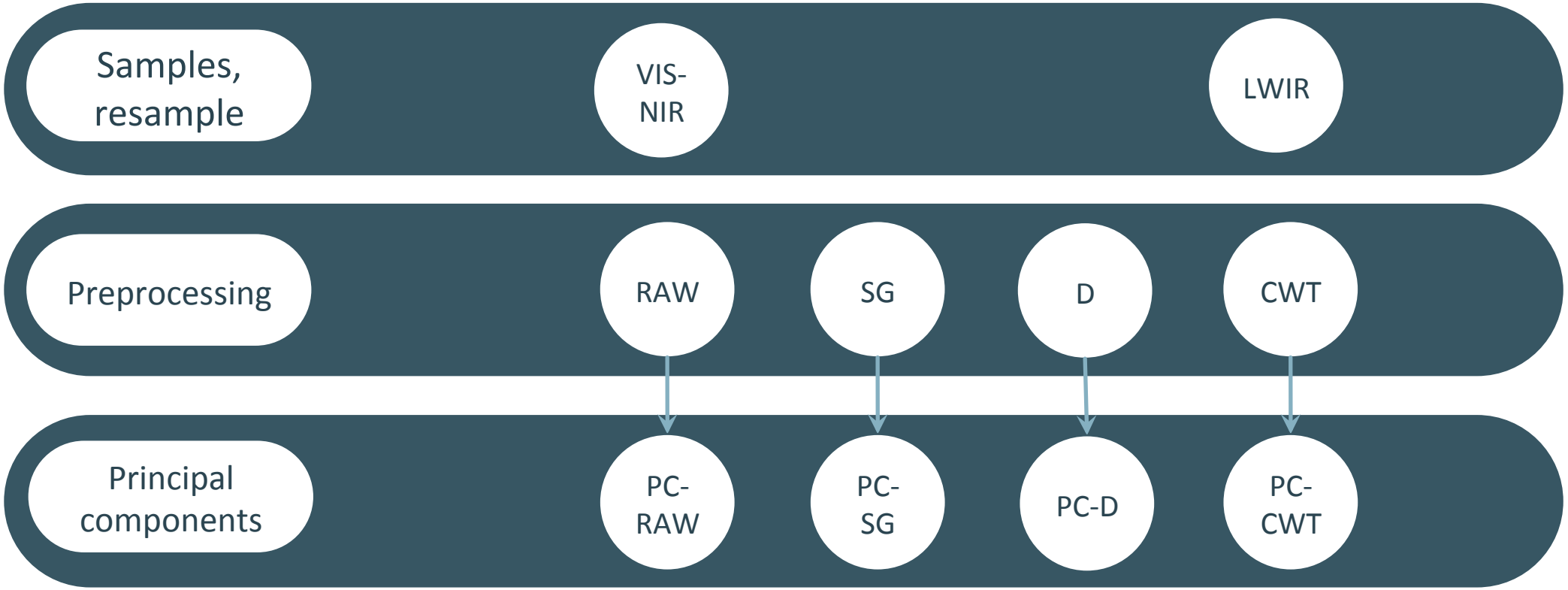
# Data processing



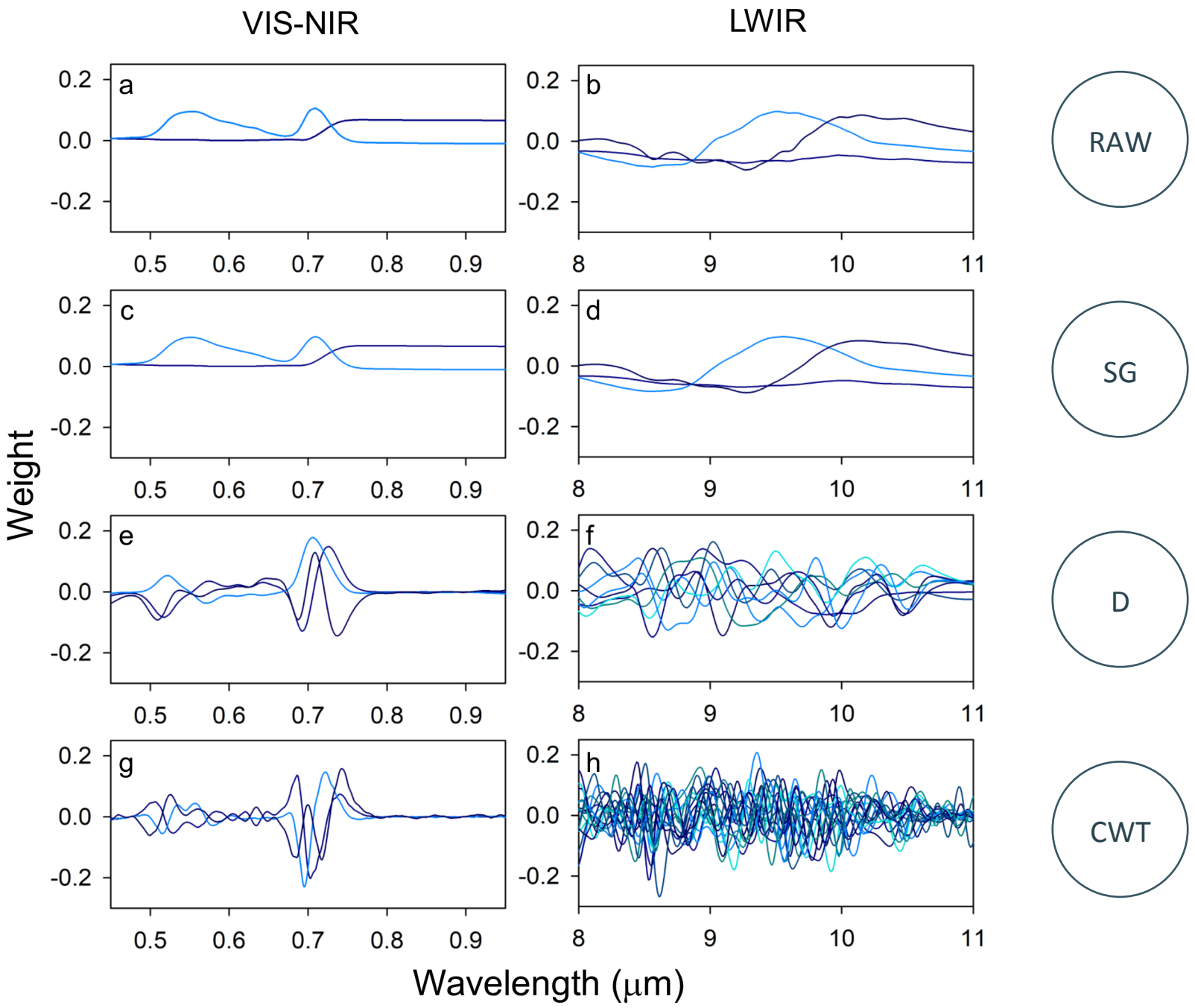
# Preprocessing



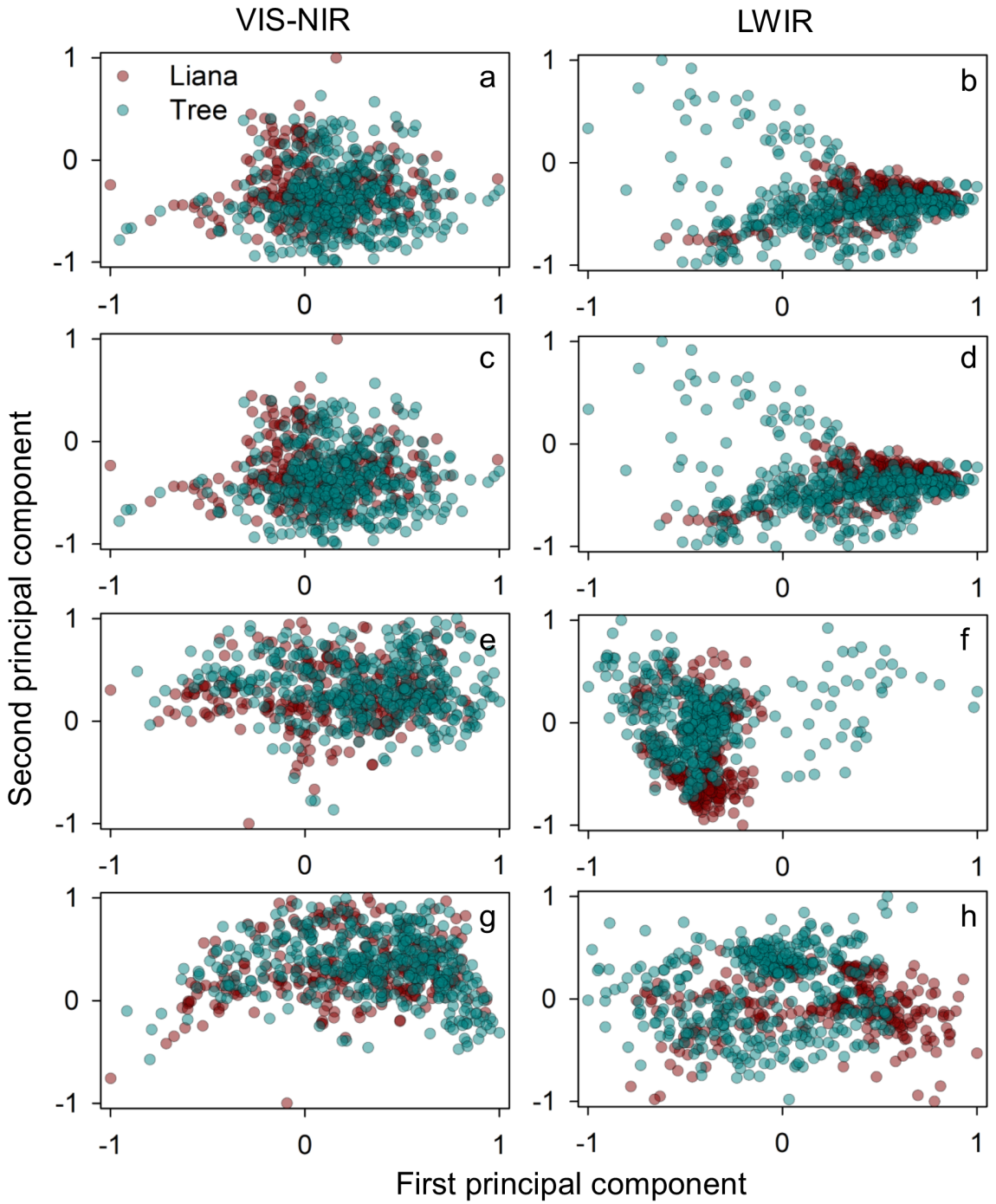
# Data processing



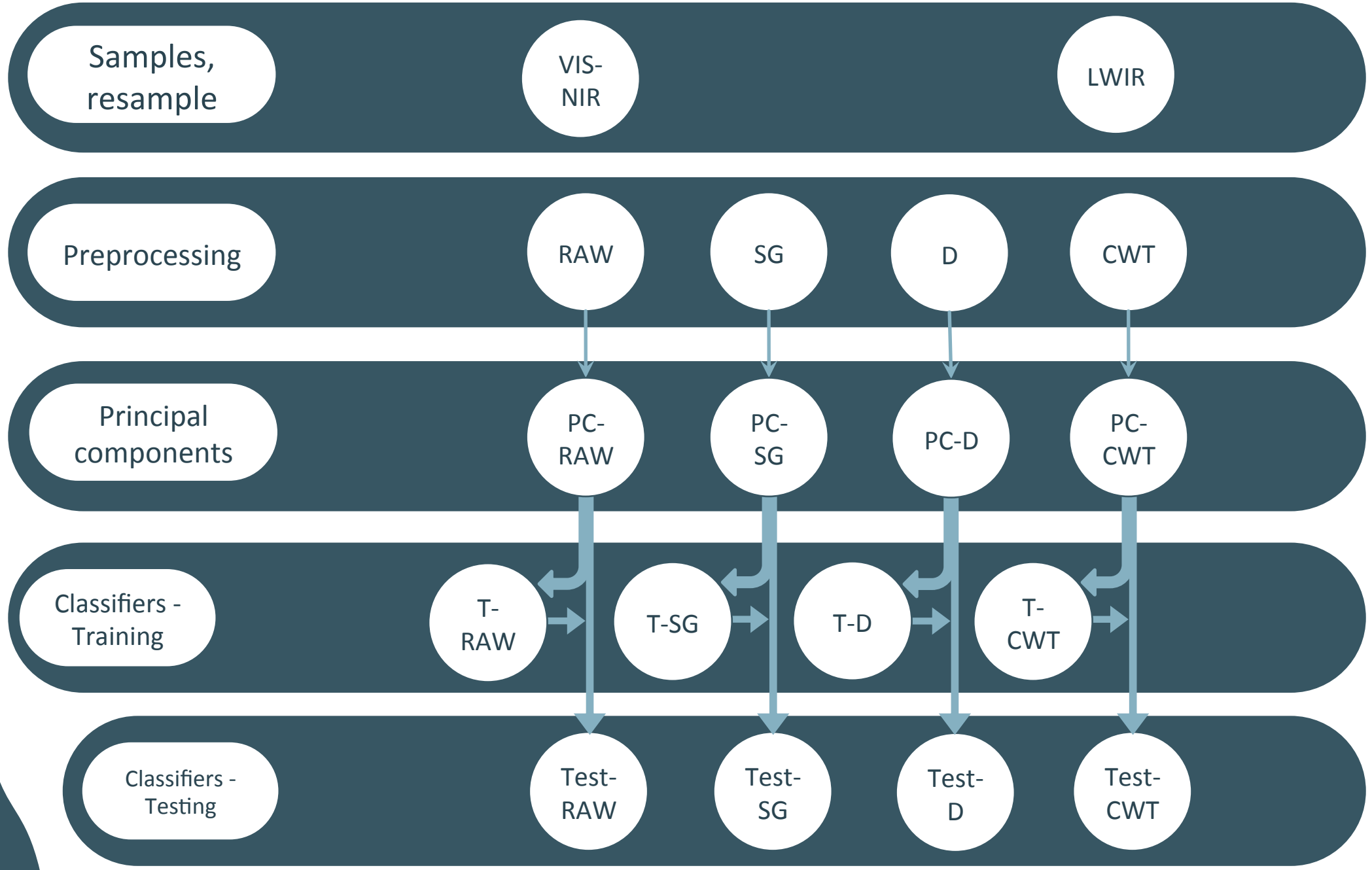
# Eigenvectors



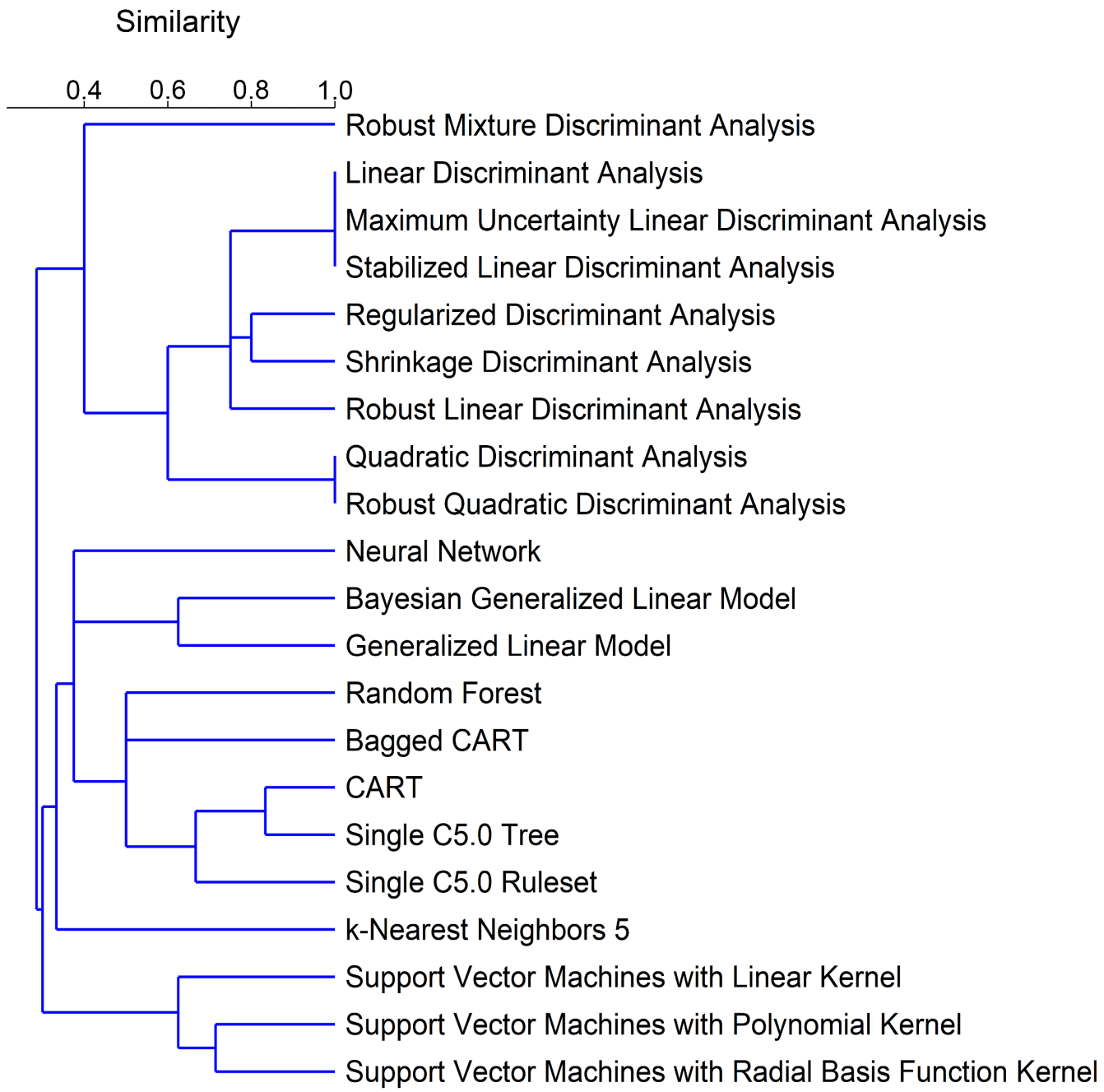
# Principal components analysis



# Data processing

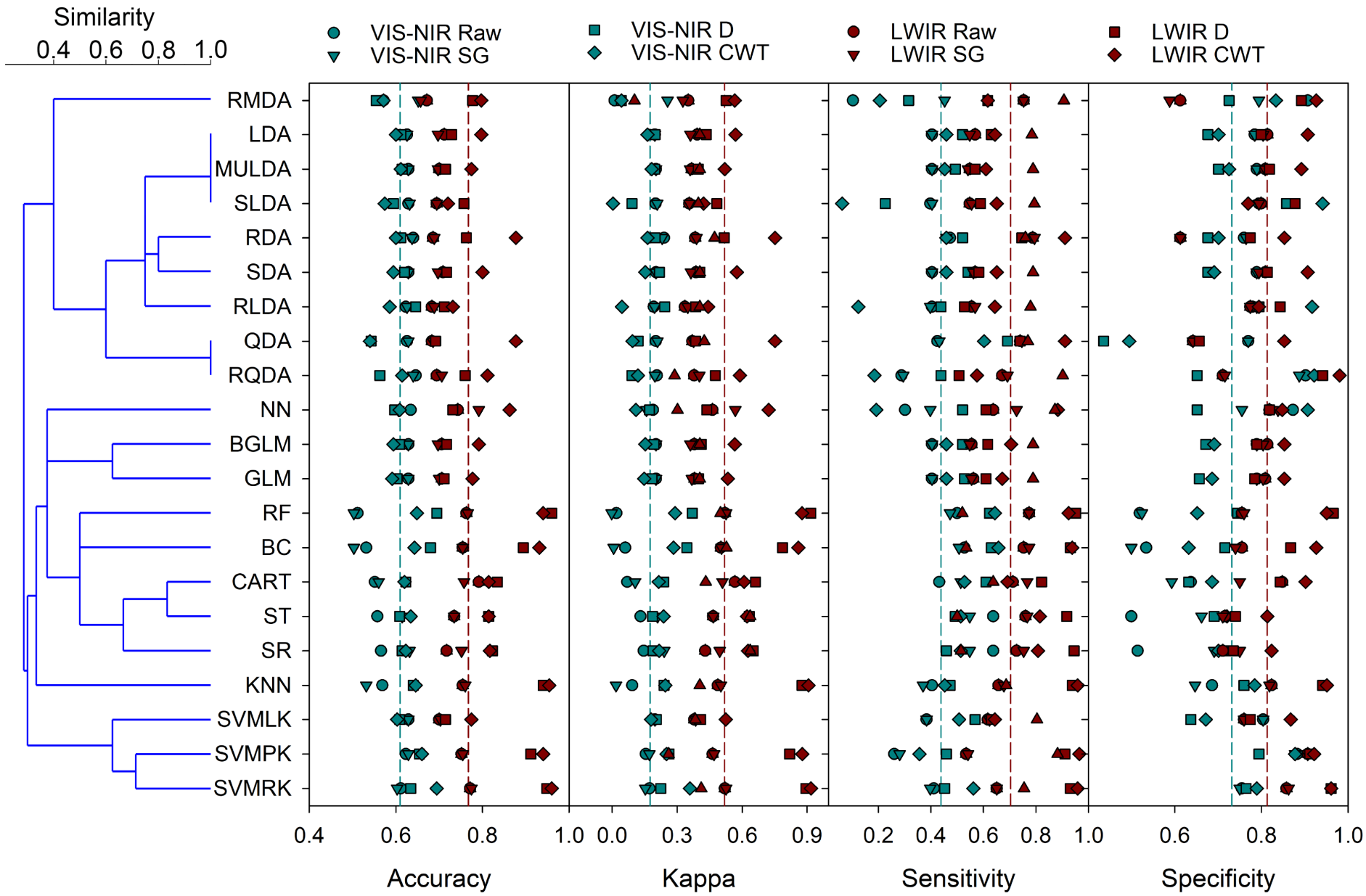


# Classifiers




Data from: http://topepo.github.io/caret

# Classifiers



# Conclusions

1

Spectral bands of importance for classification

- VIS-NIR: 680-720 nm
- LWIR: several

2

LWIR region present the highest values of classification

3

First derived and CWT seems to be better procedures for classification

4

Random forest, *k*-nearest neighbor, SVMRK seems to be the best classifiers to discriminate lianas and trees at the leaf level

Future directions - New perspectives

Forest mapping?

Functional traits - spectroscopy

# Acknowledgments

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