



Spatial and seasonal patterns of NDVI along a rainfall gradient in an African savanna

Preliminary Results

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Introduction: Background

- Understanding of savanna leaf phenology of great importance
- Possible effects of human-induced climate change to the timing and duration of phenological cycles
- Effect to global CO₂ and other ecosystem processes
- Reliable leaf phenology models are essential
- Great resource in large and long term remotely sensed data
- Only of use if the contributions to the landscape greenness can be separated into the main functional vegetation types

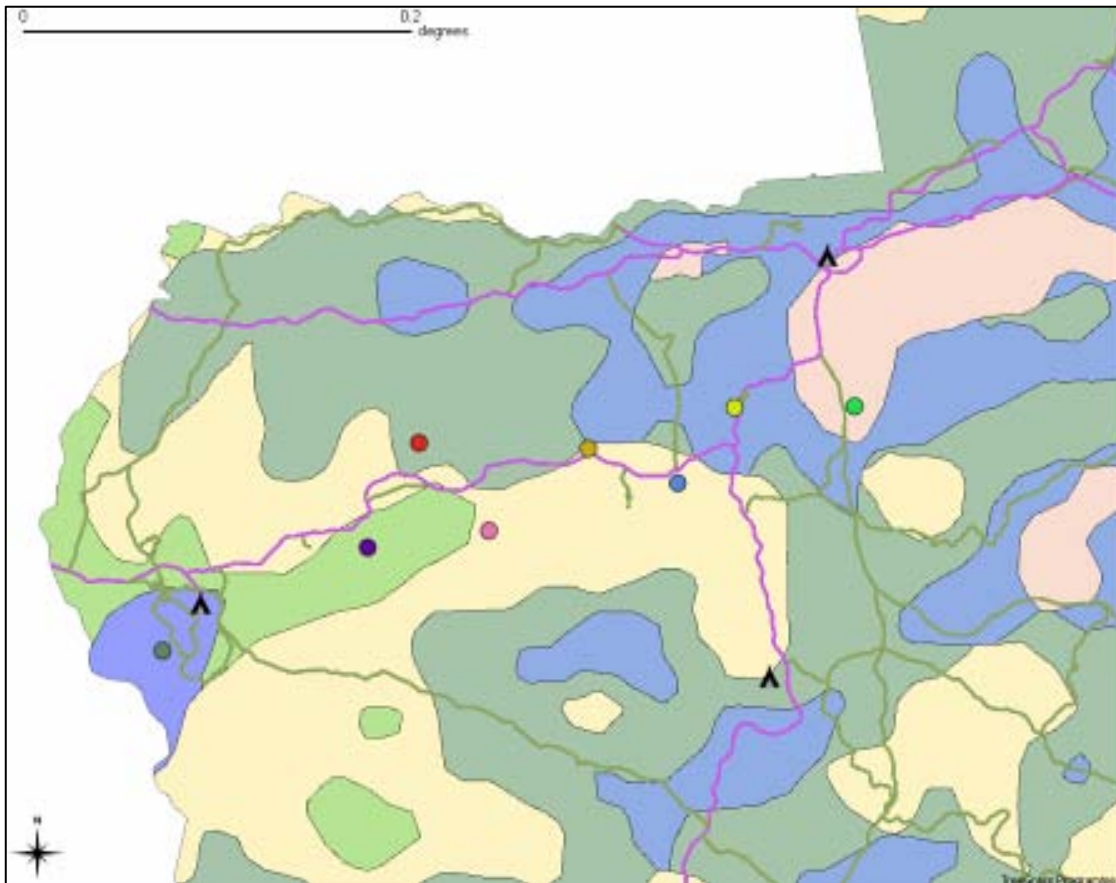


Introduction: Goals

- To evaluate phenological patterns (indexed by NDVI) of savanna landscapes
 - Time: along the rainy season
 - Space: Rainfall gradient
- To determine the partial contribution of trees and grasses to the total landscape greenness (NDVI)
- To evaluate associations between phenological response and environmental variables
- To evaluate whether phenological patterns of grasses and trees in savannas are consistent with Scholes and Walker's temporal niche separation hypothesis

METHODS: Rainfall gradient

TreeGrass Programme Weather Station Transect – Rainfall (mm)								
Rainfall	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
2008-09-01/2009-03-24	777.4	653.6	629.0		552.2	552.2	743.2	886.0
2007-09-01/2008-08-31	531.8	545.6	527.0	589.8	525.0	525.0	534.8	544.8
Long Term Average	450-500	500-550	600-650	600-650	600-650	550-600	650-700	700-750






Figures: Transect weather station locations & weather stations

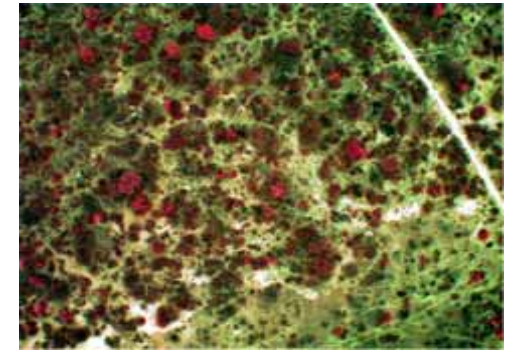




METHODS: NDVI data collection



-  Green Band
-  Red Band
-  NIR Band
(>520nm-920nm<)



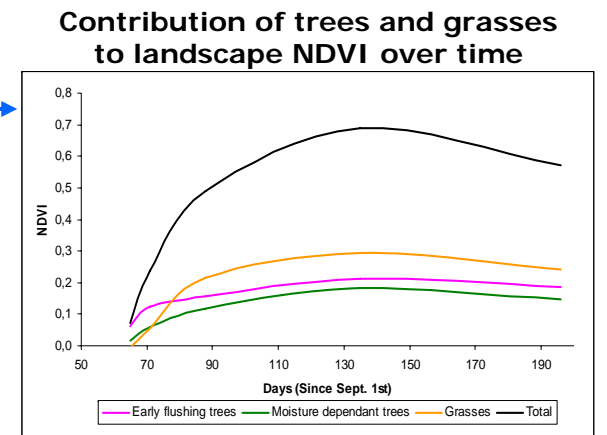
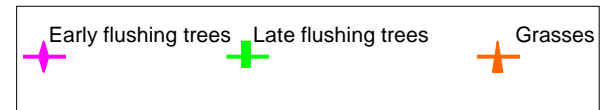
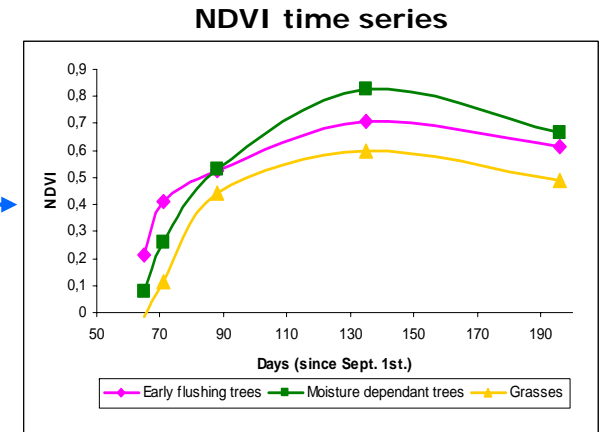
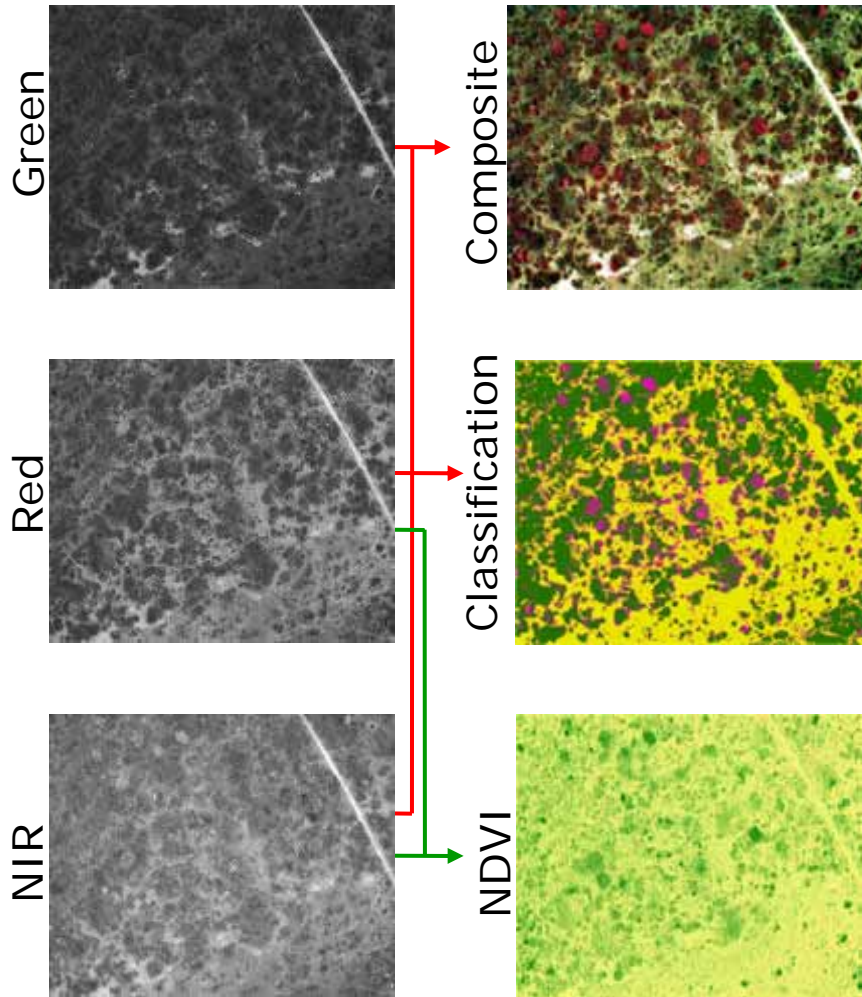
Flights characteristics:

Altitude: 450m a.g.l
 Area: 375m x 280m
 10.5 ha

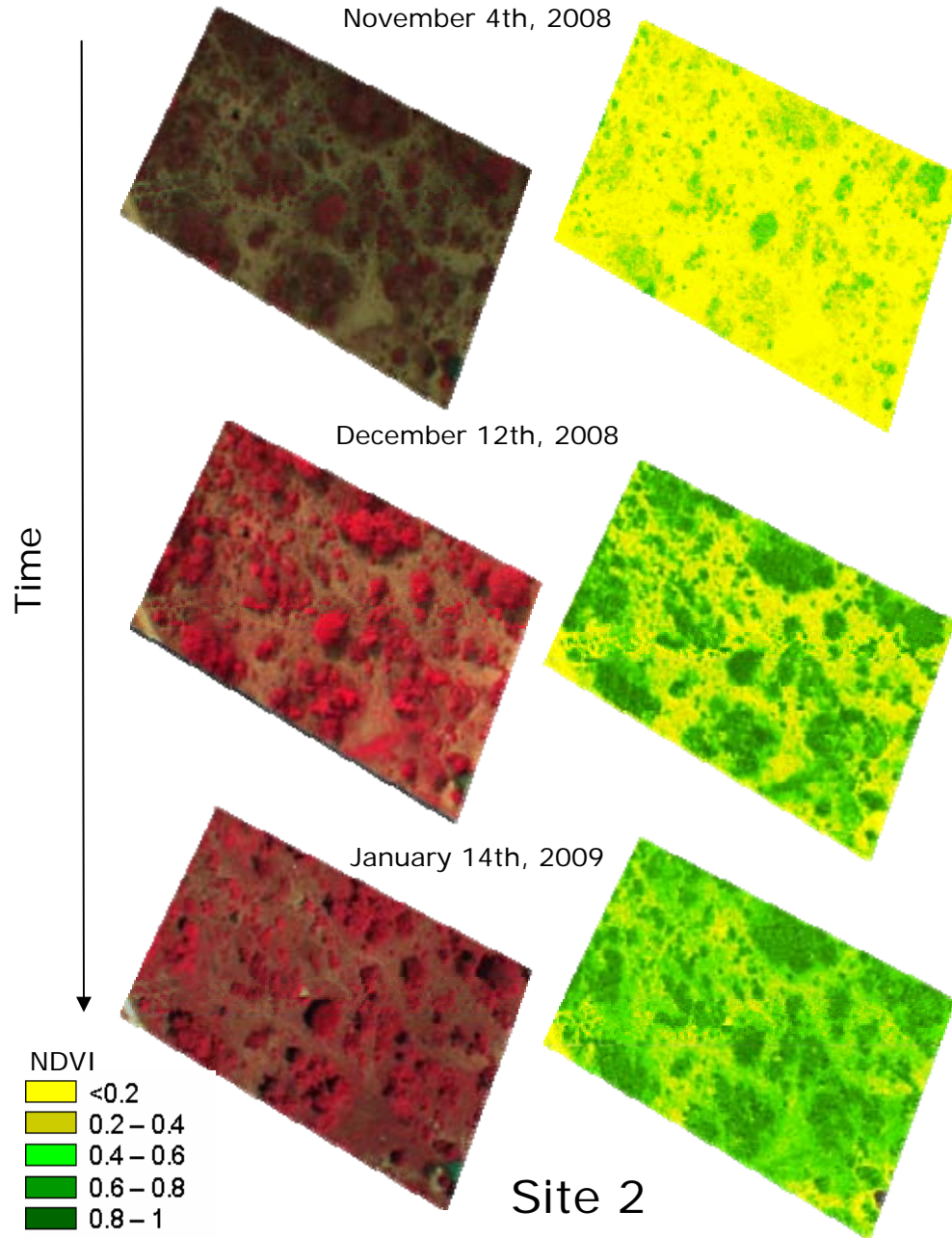
Flight	Date	Days since Sept. 1st
1	November 4 th , 2008	65
2	November 11 th , 2008	71
3	November 28 th , 2008	88
4	December 12 th , 2008	102*
5	January 14 th , 2008	135
6	March 17 th , 2008	169

* Camera malfunction (images lost)

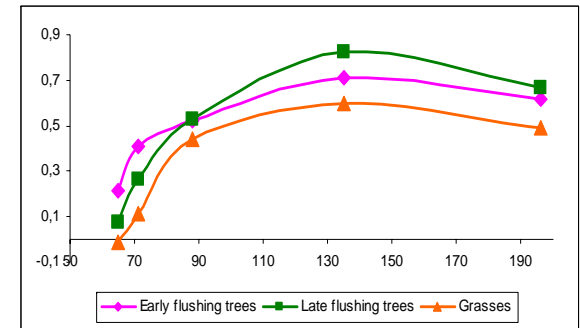
METHODS: Data processing



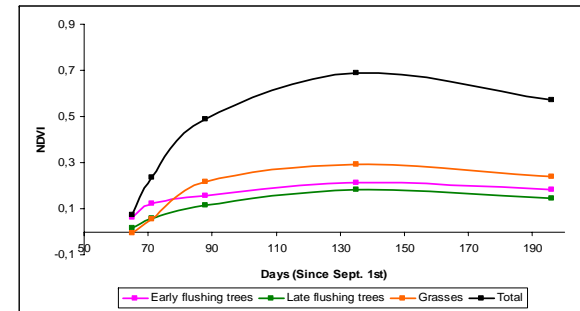
Results: Landscape NDVI & Phenological patterns



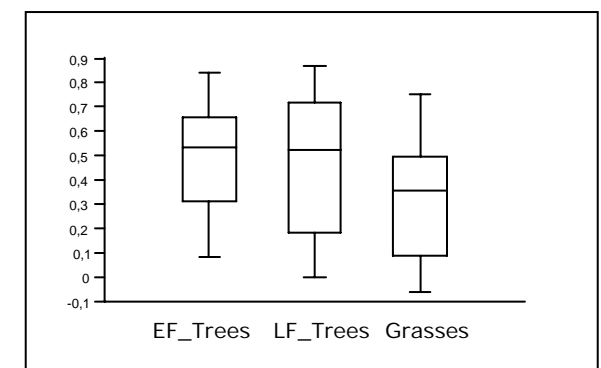
NDVI per cover type over time



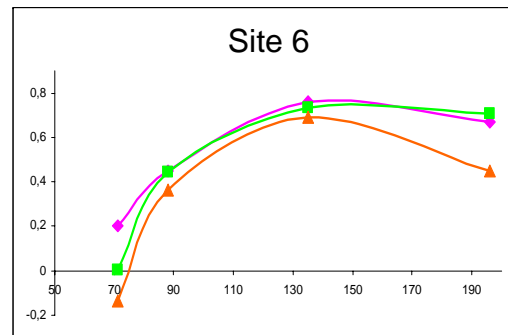
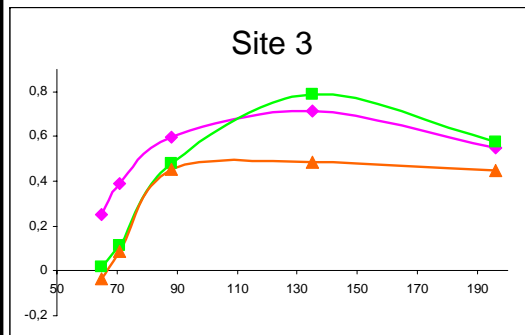
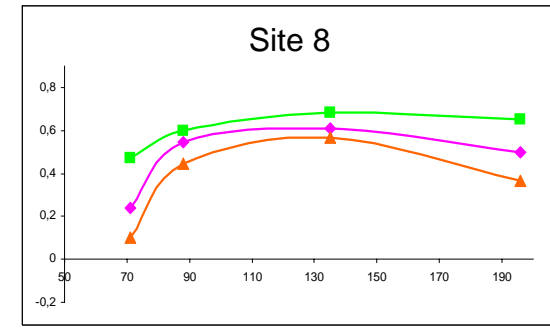
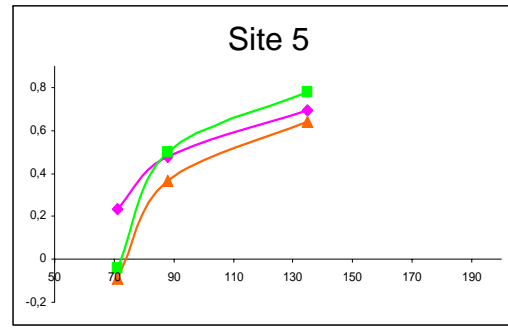
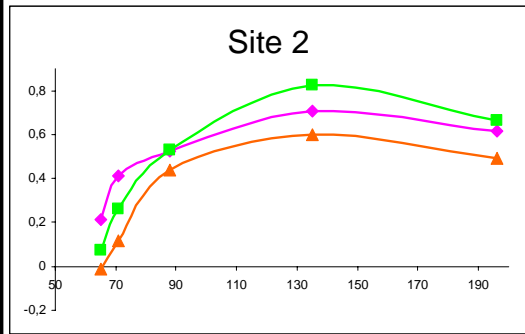
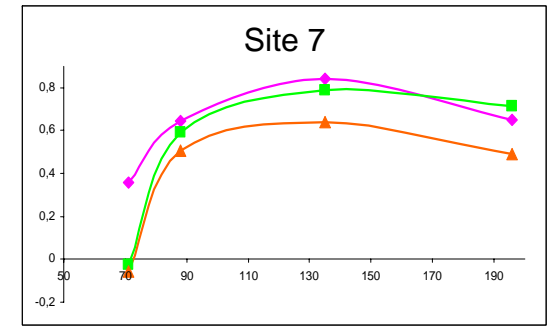
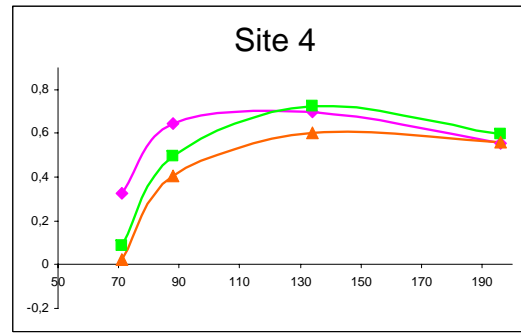
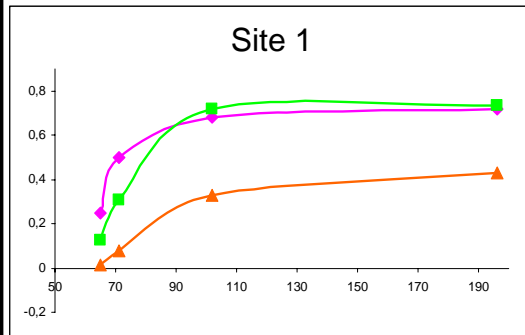
NDVI partial contribution of cover types over time



NDVI variability and cover types

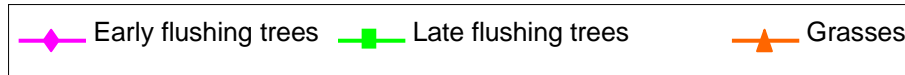


Results: Landscape NDVI & Phenological patterns

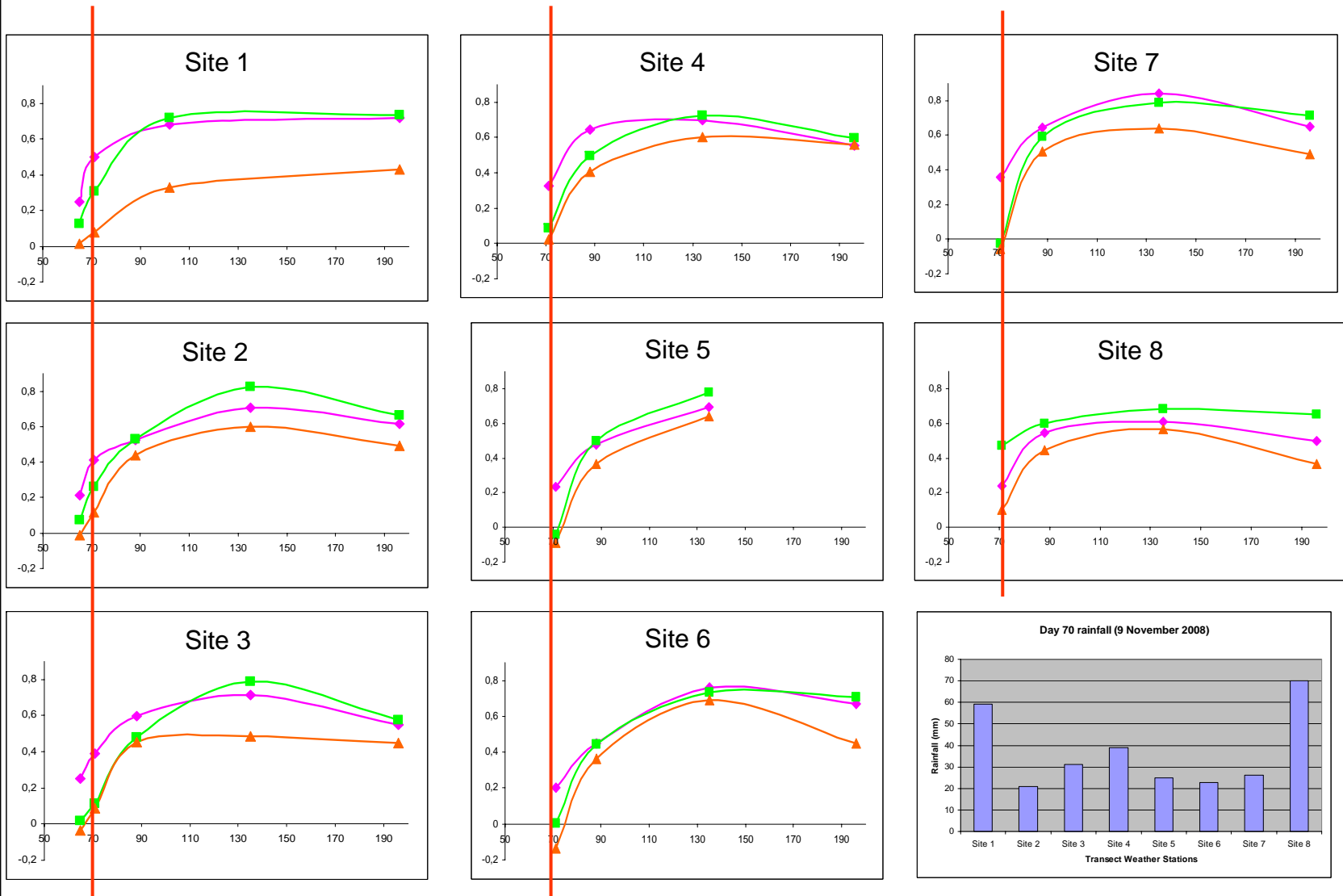


X-axis = Days from 1st of September 2008

Y-axis = NDVI

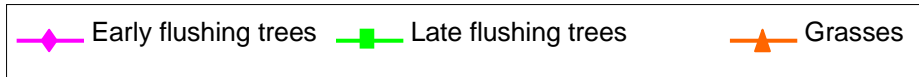
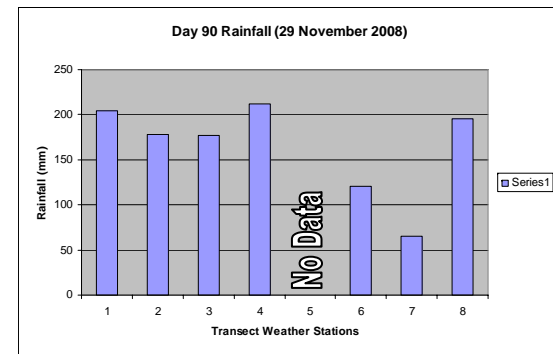
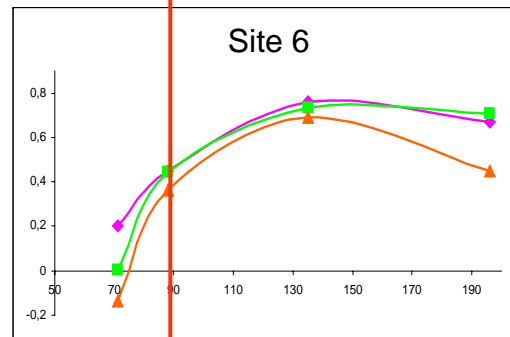
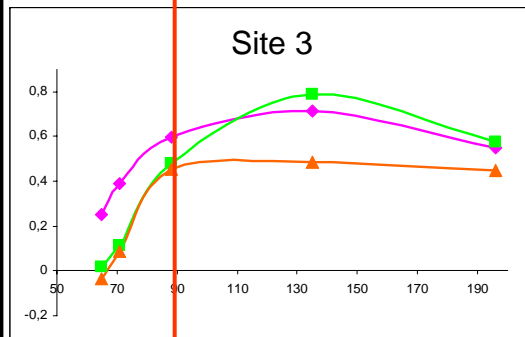
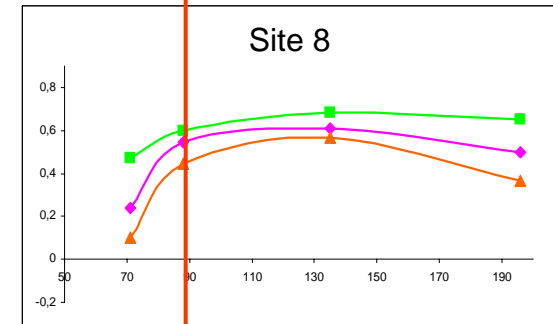
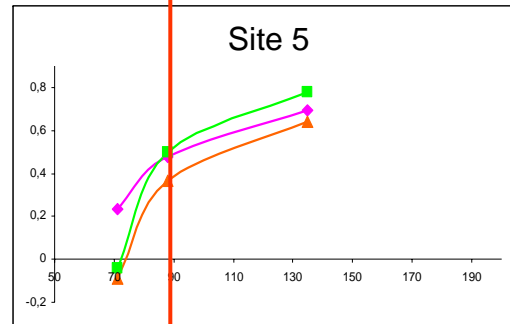
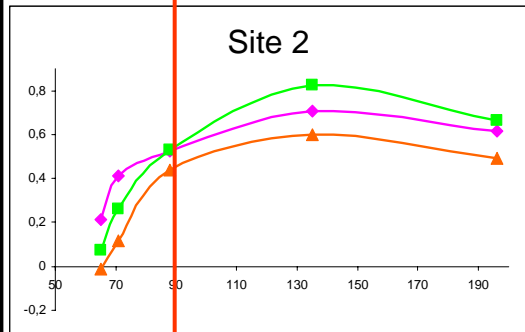
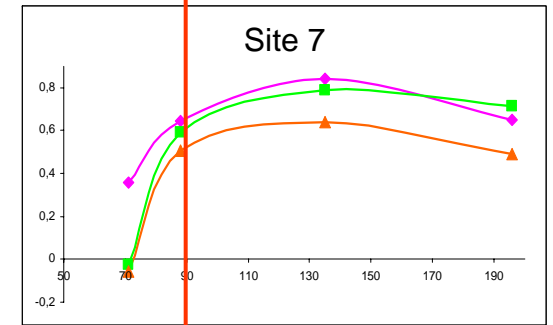
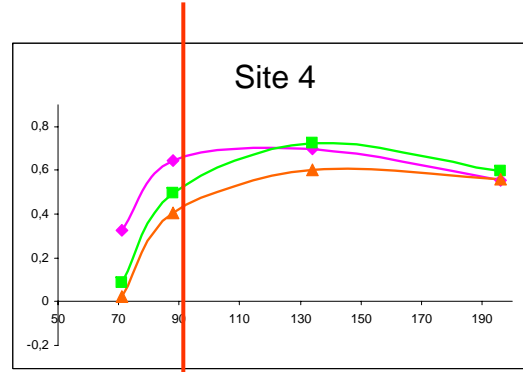
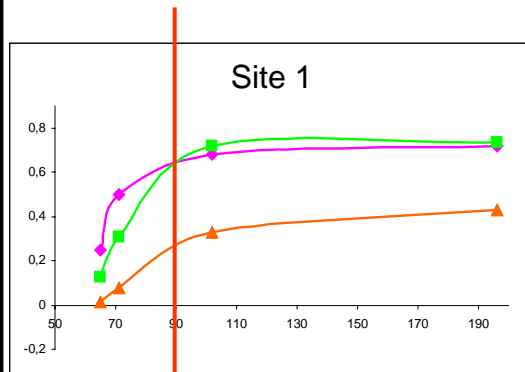


Results: Phenological response and environmental variables



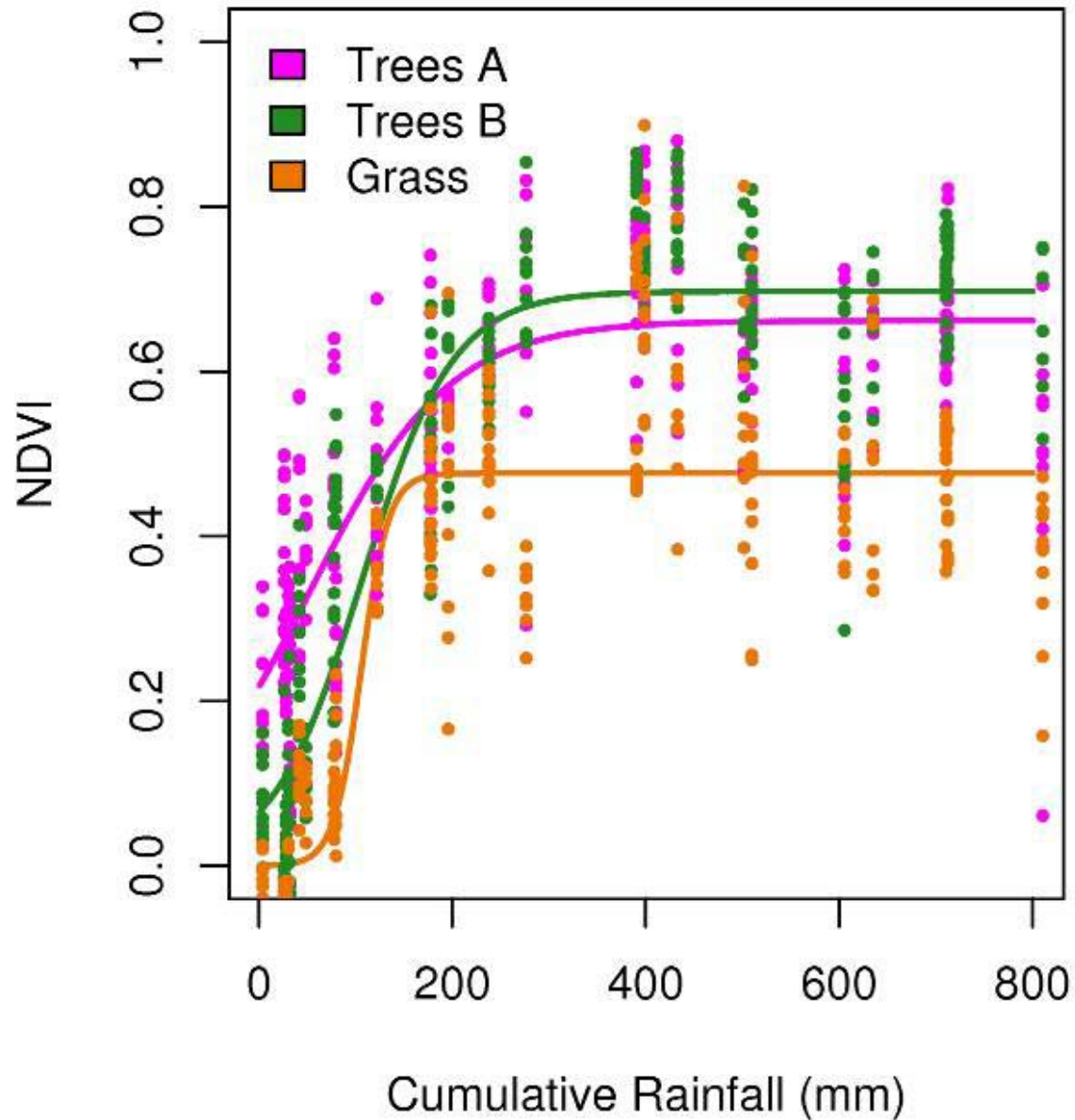
◆ Early flushing trees
 ■ Late flushing trees
 ▲ Grasses

Results: Phenological response and environmental variables



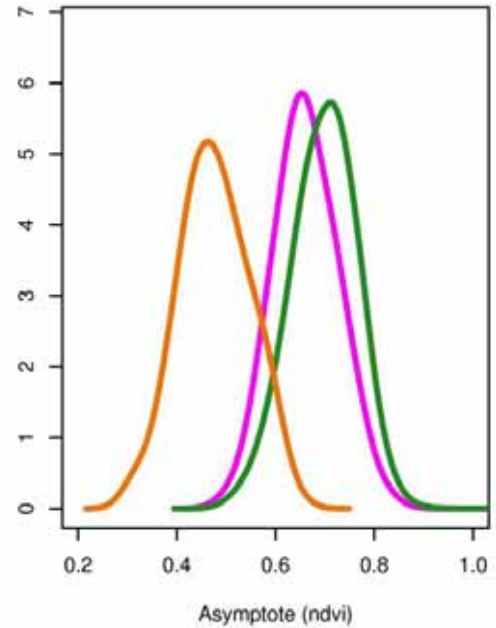
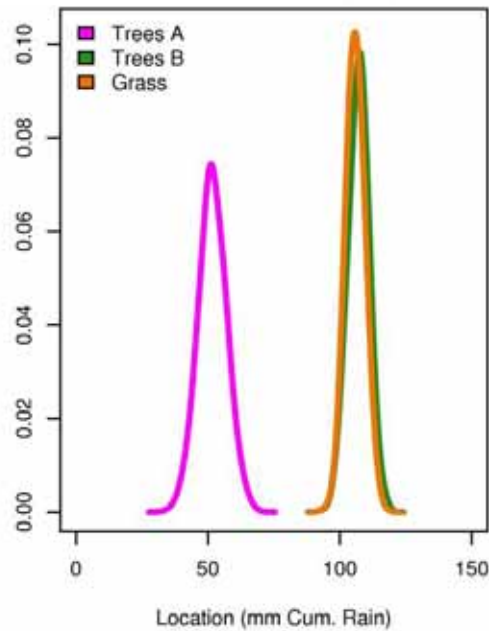
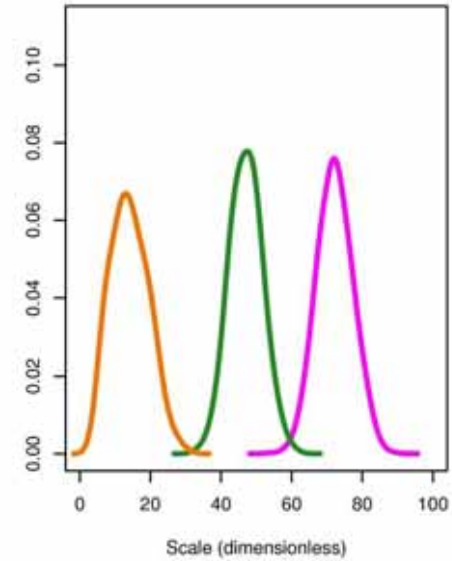
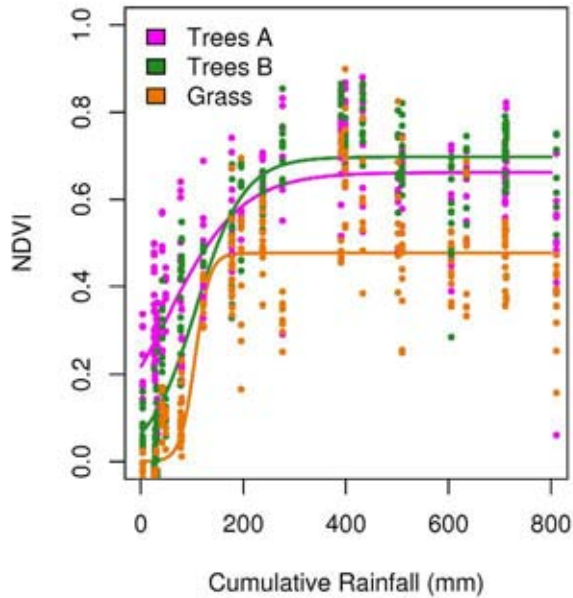


Results: Phenological response and environmental variables (cumulative rainfall)





Results: Phenological response and environmental variables (cumulative rainfall)



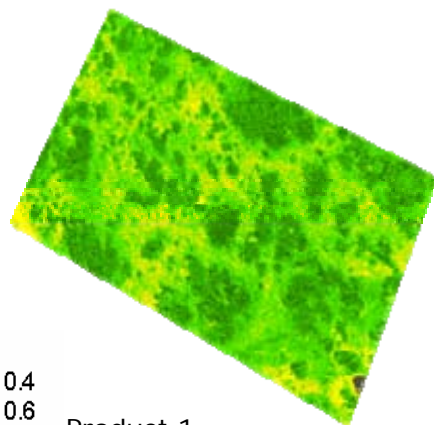


Results: Estimating cover of grasses, early and late flushing trees

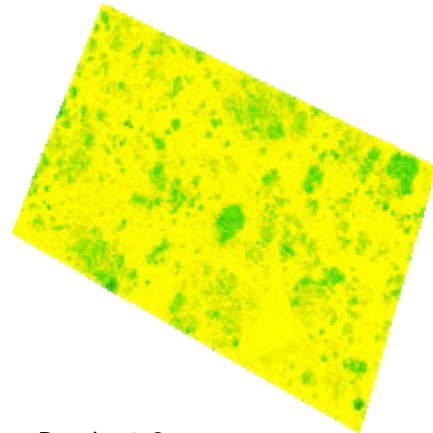
- Scaling up to total NDVI
 - Product 1: Classify grass and tree from a peak season image
 - Product 2: Classify early flushing trees from early season image
 - Late flushing trees: Product 1 – Product 2

March 17th, 2009

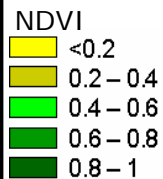
November 4th, 2008



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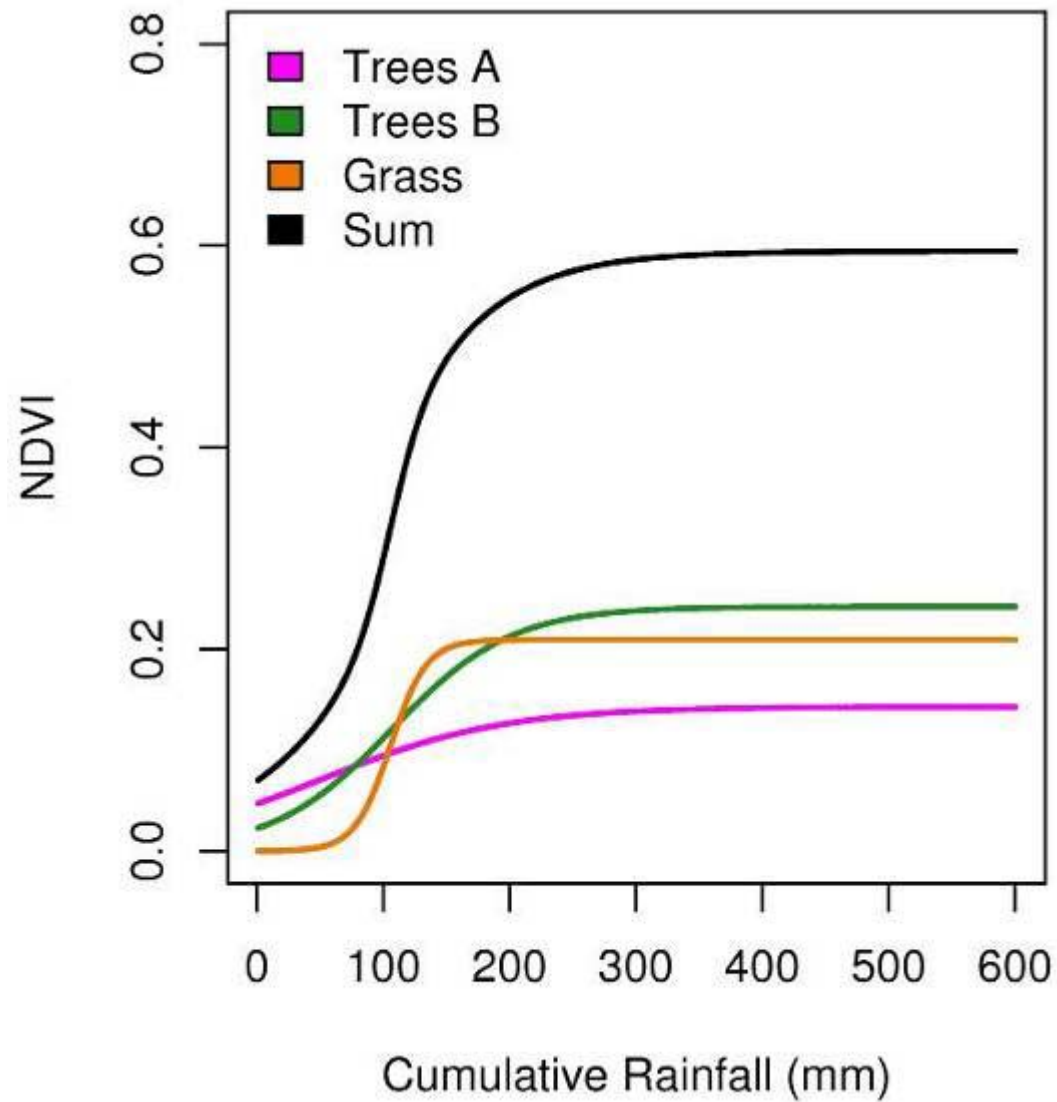


Product 1

Product 2



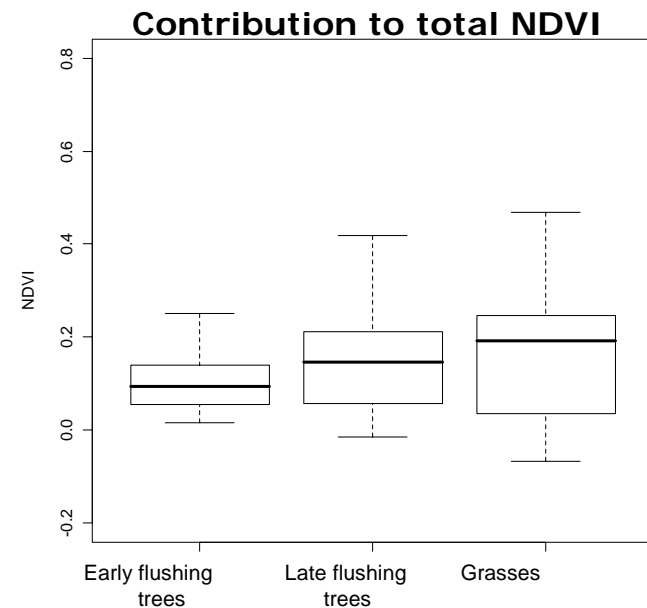
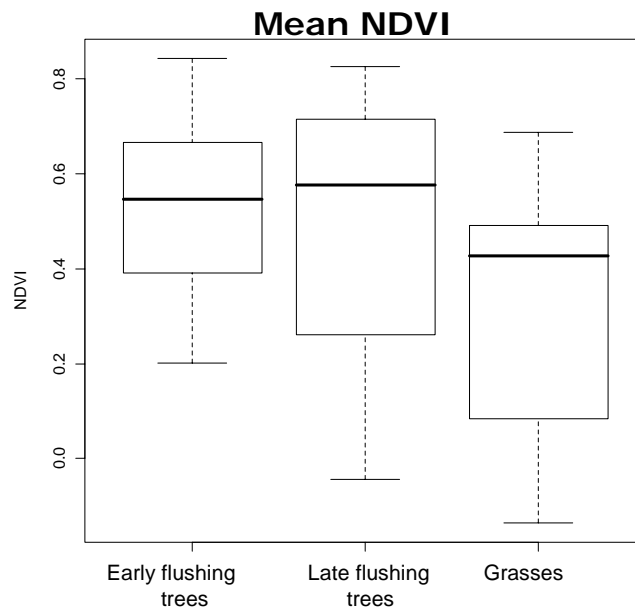
Results: Relative contribution of grasses, early and late flushing trees to stand level NDVI





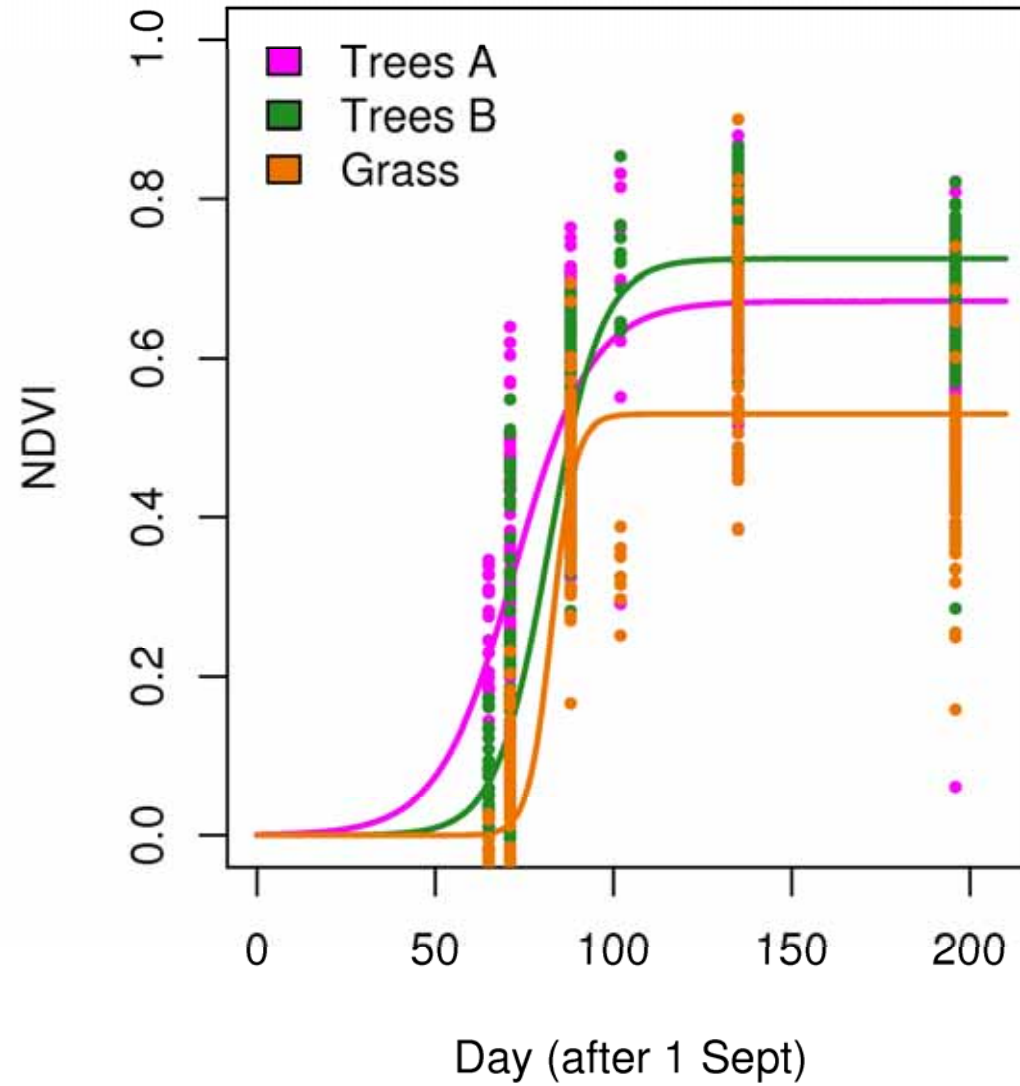
Results: Relative contribution of grasses, early and late flushing trees to stand level NDVI

- Grasses contribute the greatest percentage to total landscape NDVI values due to larger surface area covered
- Late flushing trees also contribute a significant percentage of the NDVI value later in the season
- Important to separate the contributions of late flushing trees and grasses

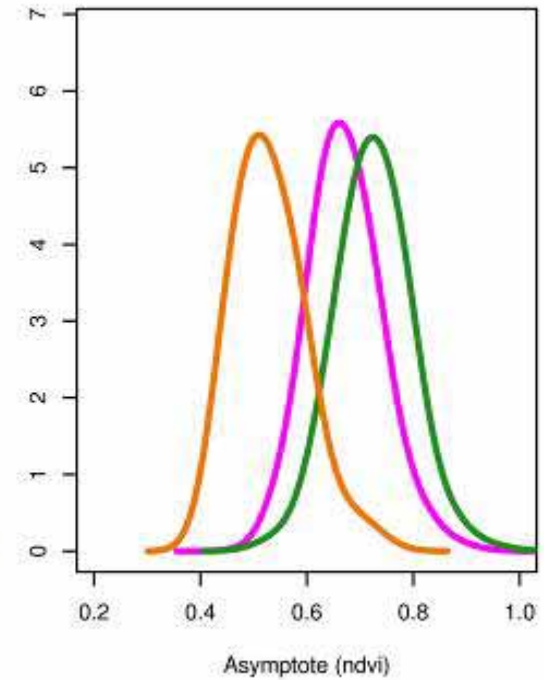
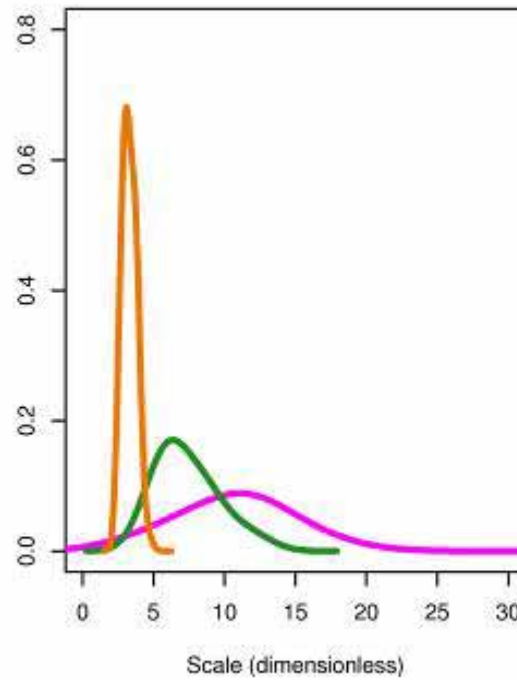
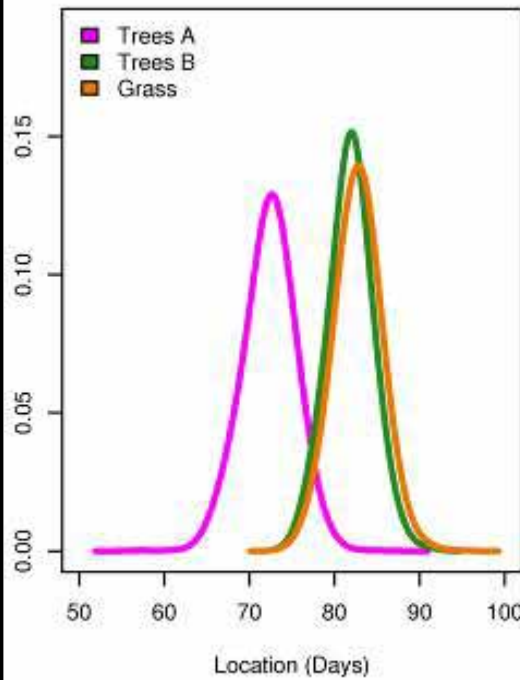
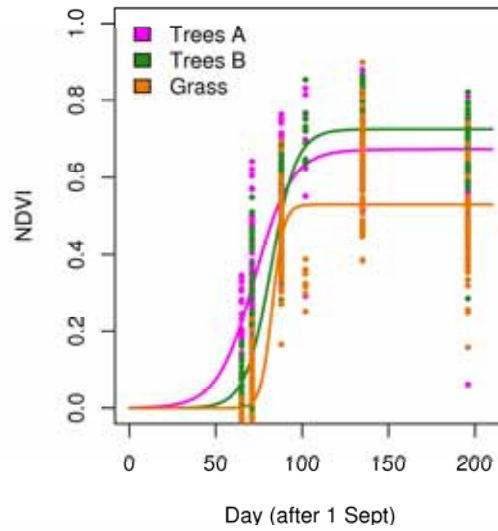




Results: Temporal niche separation hypothesis

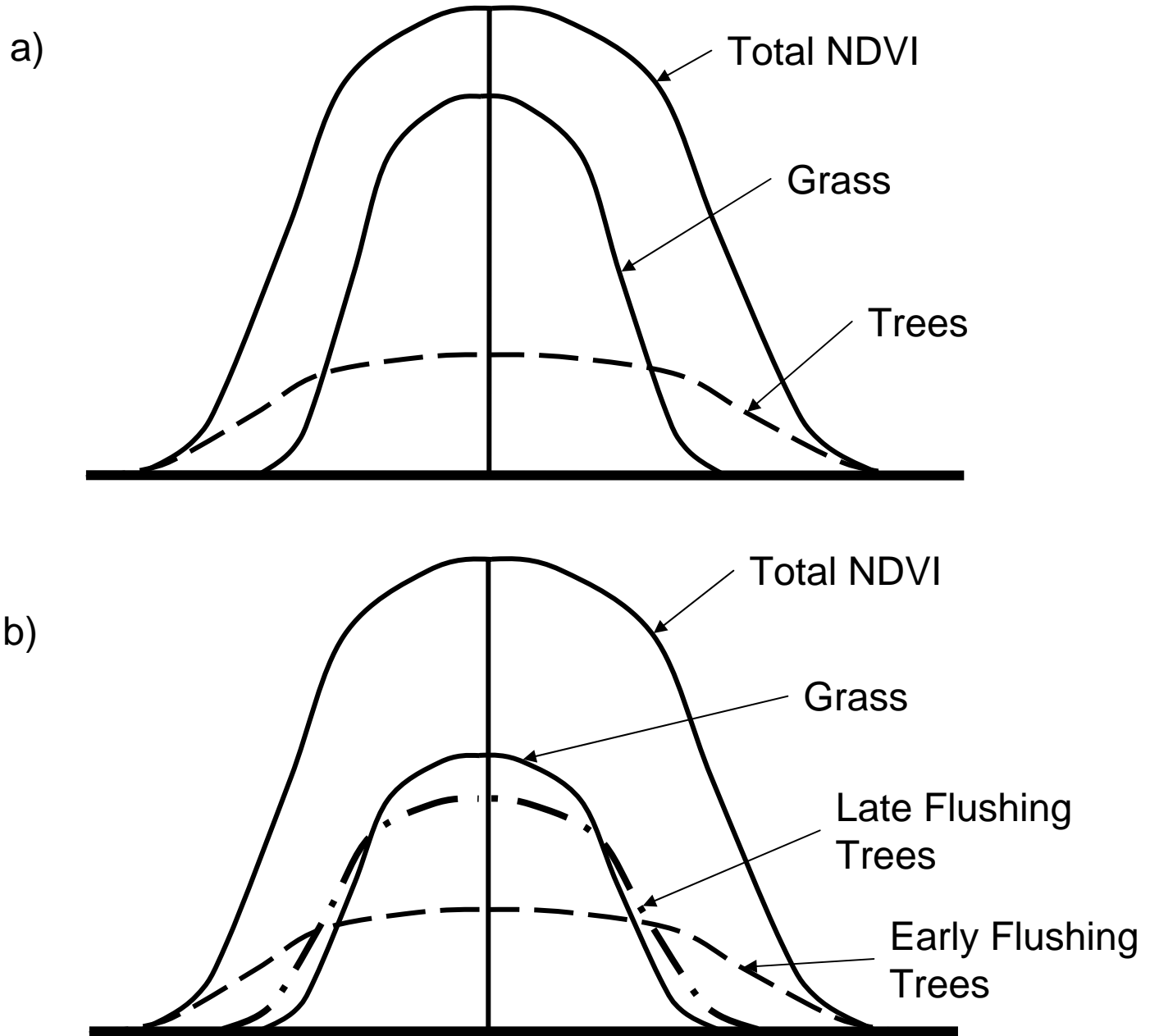


Results: Temporal niche separation hypothesis





Results: Temporal niche separation hypothesis





Conclusion:

• Phenological patterns

- Early flushing trees, less variable NDVI
- Late flushing trees, moisture dependant, more variable NDVI, higher than early flushing trees later in the season
- Grasses very variable, lowest NDVI

• Partial contribution of trees and grasses to the total landscape greenness (NDVI)

- Grasses and late flushing trees make similar contributions to the NDVI values
- Early flushing trees make the smallest contribution to total NDVI values but are less variable
- Existing methods of using phenological timing to separate grasses from trees are according to our findings invalid

• Associations between phenological response and environmental variables

- Late flushing trees and grasses start approximately 50mm later than early flushing trees.



Conclusion:

•Temporal niche separation hypothesis

- Appears not be valid for all savanna trees
- Still not clear what trees gain from temporal phenological separation
- Richard Verwey's sapflow data indicate no sap flow in Marula (early flushing tree) after leaf flush
- More data required

•Future Actions

- Expand the data set
- Identify which trees are early flushing and which trees are late flushing

Acknowledgements:

- SANParks for the use of the helicopter
- SANPark Pilots for their willingness and patience



Questions

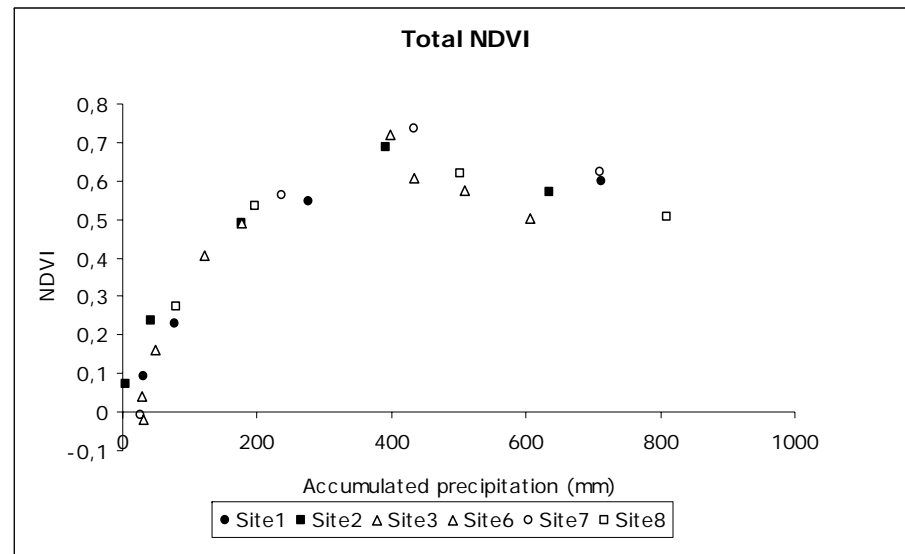
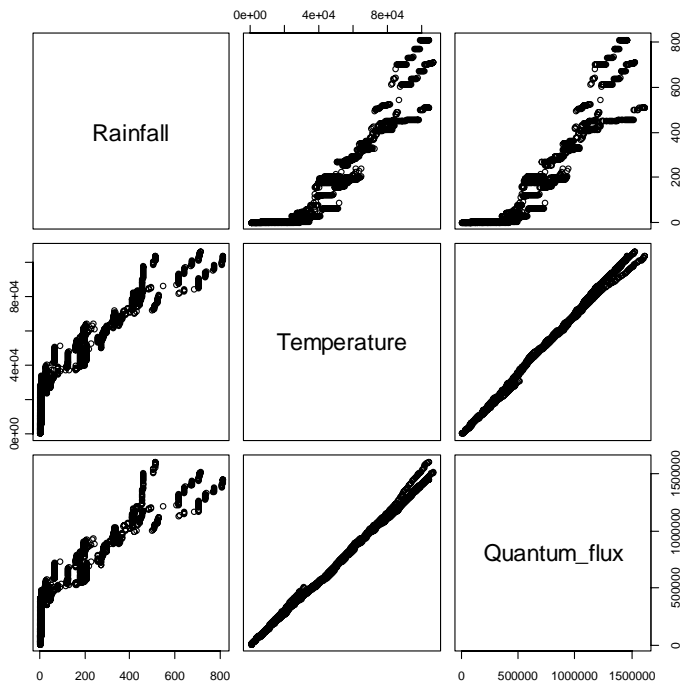


Results: Environmental drivers of NDVI

Possible relevant variables:

- Precipitation (Cumulative, starting September 1st)
- Temperature (Cumulative, starting September 1st)
- Light (Quantum flux. Cumulative, starting September 1st)

	Rainfall	Temperature	Quantum flux
Rainfall	-	0.938***	0.929***
Temperature	0.938***	-	0.998***
Quantum flux	0.929***	0.998***	-



°
mV

mm