

INTEGRATION OF SENSORS APPLIED ON SOUTH AFRICAN ECOSYSTEMS (ISAFE)

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Objectives

- Reprocessing of the 1km NOAA AVHRR data set for Southern Africa (1985 – 2000)
- Spectral library of selected South African land cover classes (low, medium and high NDVI)
- Estimation of correction functions for the integration of AVHRR, Spot VEG and MODIS sensors
- Establishment of long term archive AVHRR-VGT, AVHRR-MODIS



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Pre-processing of AVHRR imagery

- VGT

- Atmospheric correction (SMAC)
 - H2O: 6-hourly measurements from **MeteoFrance**
 - O3: climatology based on TOMS data
 - Aod: empirical function / **calculated from B0**
 - Interpolation of inputs in time and space
- Geometric accuracy:
 - **< 0.5 pixel**
 - **Resampling: bicubic convolution**
- MVC: max value TOA NDVI
- BDC: Roujean model; **unlimited time window**

AVHRR

- Atmospheric correction (SMAC)
 - H2O: 6-hourly 1 degree measurements from **ECMWF**
 - O3: climatology based on TOMS data
 - Aod: empirical function
 - Interpolation of inputs in time and space
- Geometric accuracy:
 - **mean RMSE: 1.04 pixels stdev 0.07 pixels**
 - **Resampling nearest neighbour**
- MVC: max value TOA NDVI + **constraint on VZA**
- BDC: Roujean model; **time window limited to 2 months**



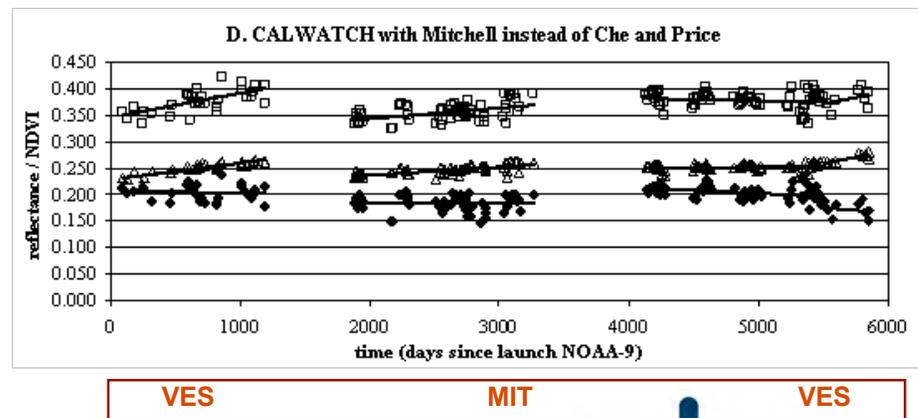
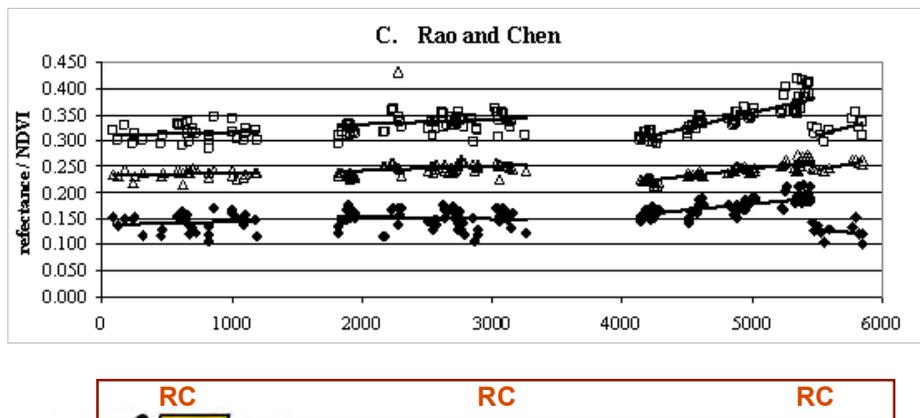
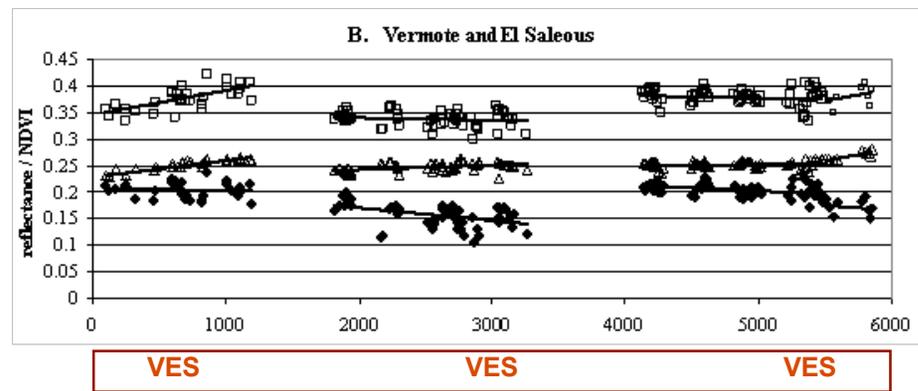
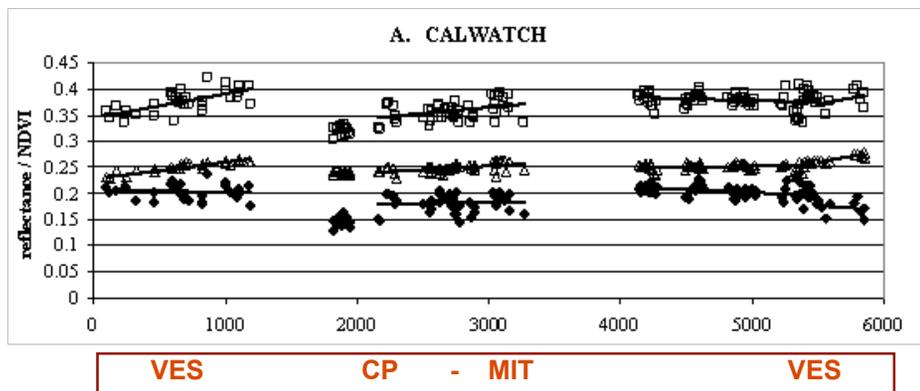
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Calibration

Validation on Namib desert : NOAA-9, 11 and 14

Vermote and El Saleous for NOAA-9 and NOAA-14, Mitchell for NOAA-11. As recommended by Calwatch



BRDF

- **NTAM** = Non-linear Temporal Angular Model (Latifovic)
- Very low R^2 between actual values and model fit for low vegetation classes and the R^2 decreased as the gap fraction increased.
- The method works well on densely vegetated areas.
- **Conclusion: for BRDF-correction, if the model does not fit well to your actual values, you only introduce additional noise (is so for BDC-algorithm and NTAM on this dataset). Then it's better not to correct for BRDF.**



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Integration of AVHRR and VEGETATION archive

- Based on overlapping year 1998
- Sources of inconsistency:
 - **BRDF-effects : different overpass time**
 - **Spectral Response Function (SRF)**
 - **Point Spread Function (PSF)**
 - **Mis-registration errors**



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Methodology

- Acquisition of ASD spectra (400-1200nm) of various land cover classes
- Convolution of SRF and ASD measured spectral signatures per land cover class in order to simulate sensor response

$$\bar{\rho} = \frac{\sum \omega_n \rho_n}{\sum \omega_n}$$

- Calculation of NDVI

$$NDVI = \frac{\bar{\rho}_{NIR} - \bar{\rho}_{Red}}{\bar{\rho}_{NIR} + \bar{\rho}_{Red}}$$

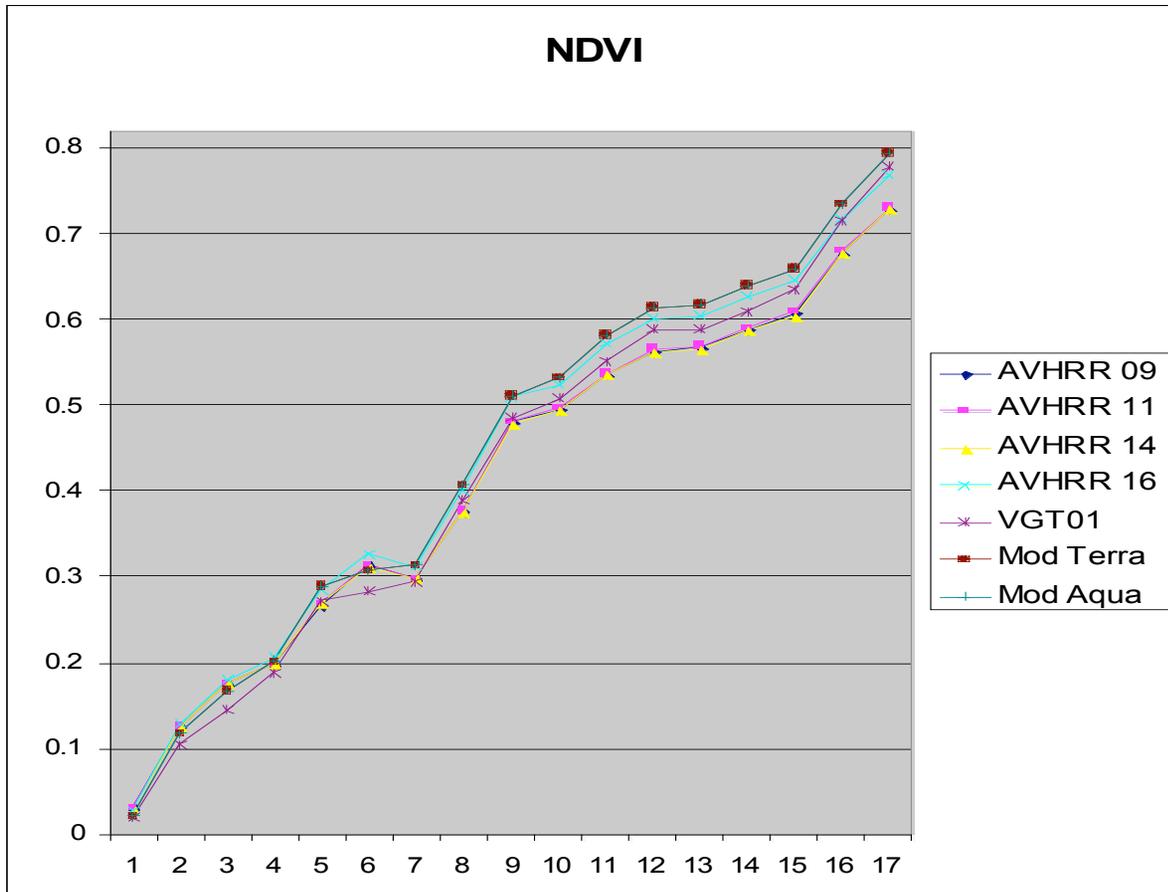
- Calculate correction functions based on polynomial fit for absolute as well as relative differences between sensors responses
 - All sensors are compared relatively to each sensors



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NDVI values calculated from simulated sensor responses



ASD Sites

1	Bare Rock_site7
2	Bare Soil2_site8
3	Bare Soil1_site5
4	Oschrub_siteB1
5	OGrass2_siteB4
6	Degraded Woodland2_site6
7	Oschrub2_siteB2
8	OGrass1_siteB3
9	Dry Grass_site12
10	Dense Woodland_site3
11	Green Grass_site13
12	Young Grass_site14
13	Open Bushland2_site10
14	Open Woodland_site9
15	Pumpkin1_site4
16	White Maize_site15
17	Sugar cane_site11

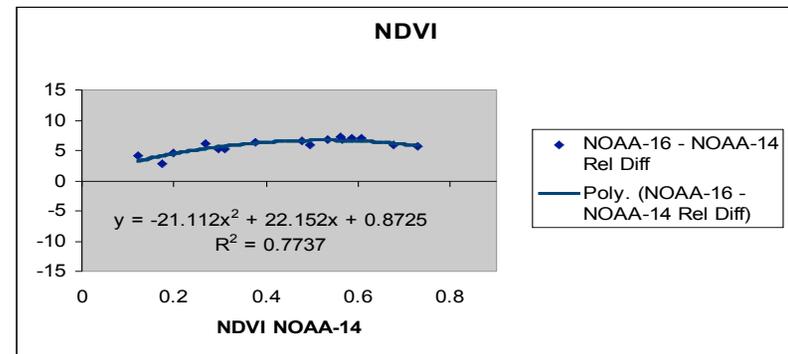
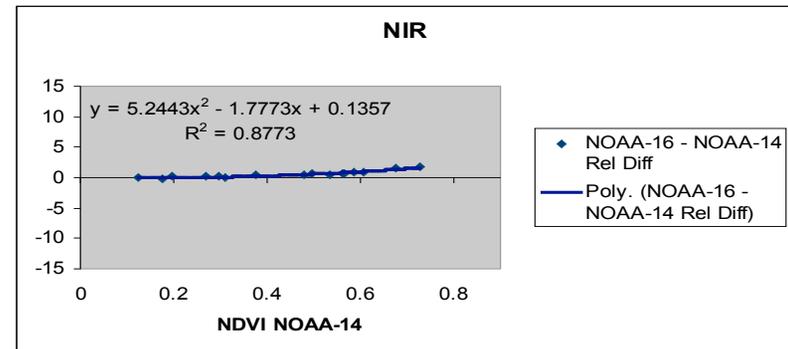
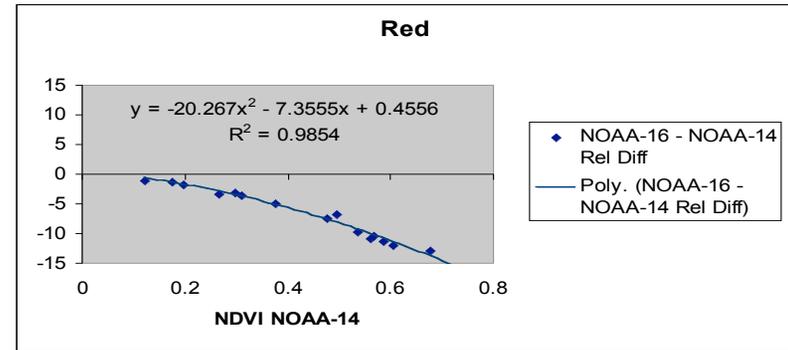
Methodological approach

Steven et al. 2003	Trischenko et al. 2002	ISAFE
Agricultural sites	Boreal region	Southern African Land Cover
SRF	SRF	SRF
ASD (Field)	Spectral curves form (ASTER & PROBE)	ASD (Field)
NDVI TOC	Red, NIR, NDVI TOC & TOA	Red, NIR, NDVI TOC
	Abs & Relative difference in relation to AVHRR-9	Abs & Relative difference compared all with all
Linear transformation	2 nd Oder Polynomial	2 nd Oder Polynomial



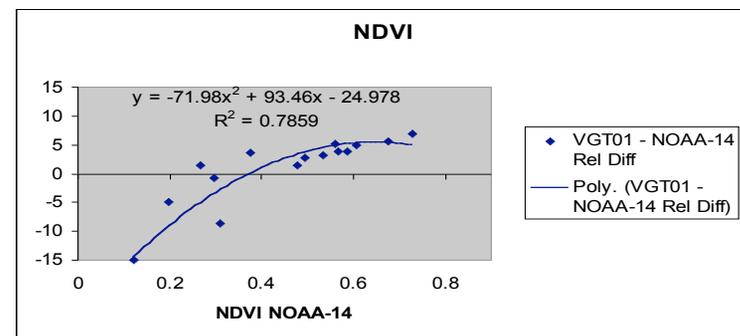
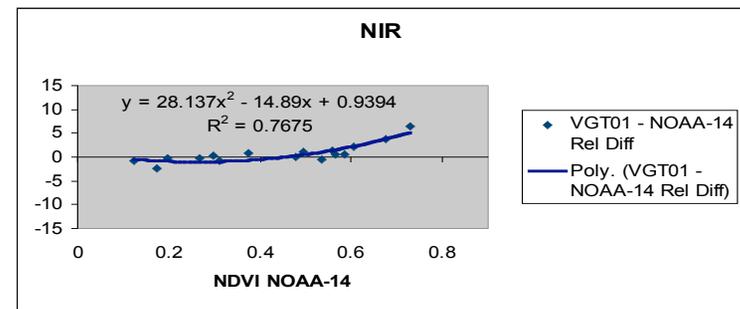
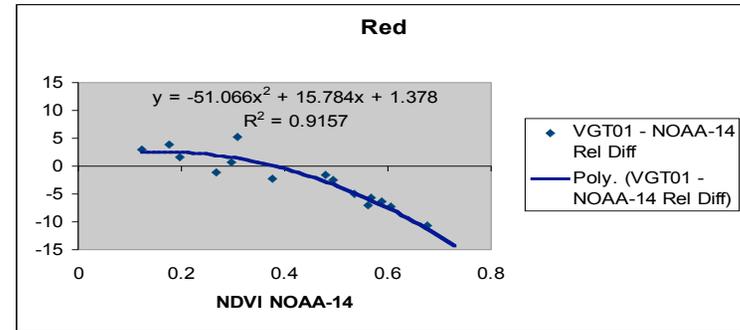
Results

- **Comparison of AVHRR sensors**
 - Analysis of 3 families of AVHRR sensors indicate difference between responses is NOT random but is related to amount of green vegetation
 - High correlation between NOAA-9 & NOAA-11 therefore no correlation functions required between them
 - NDVI of NOAA-14 (for vegetated surfaces) is 0.3% lower than NOAA-9 and NOAA-11
 - NDVI of NOAA-16 is about 5% higher than the NDVI of NOAA-9, NOAA- 11 & NOAA-14: A simple correction of 5% suggested,
 - However there is NO imagery overlap between NOAA-16 with AVHRR sensors onboard NOAA-9, 11 & 14



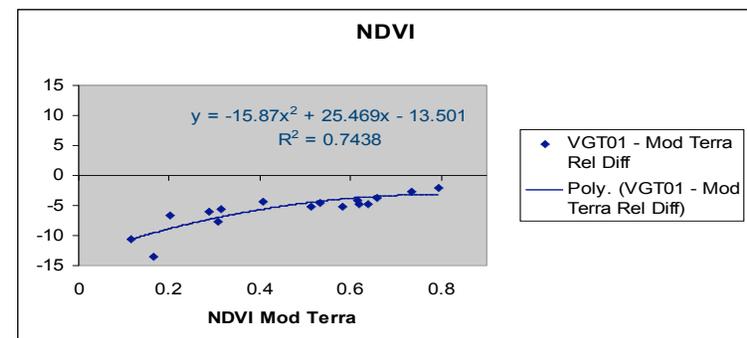
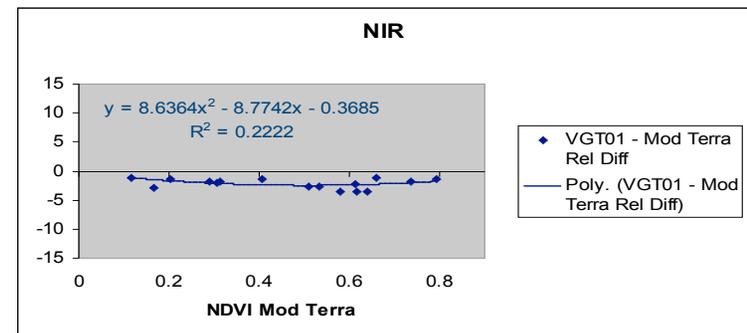
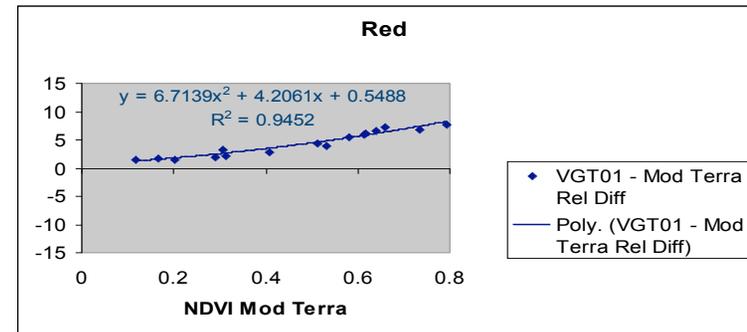
Results

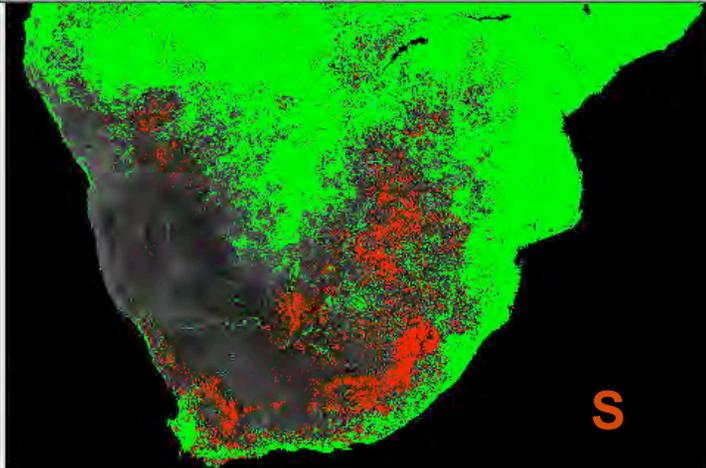
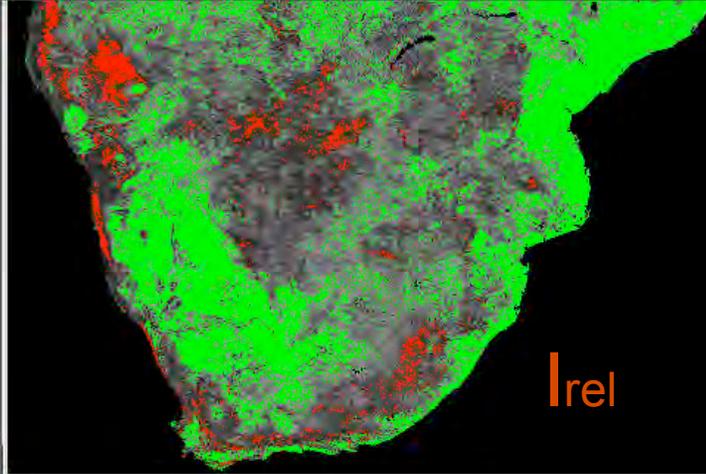
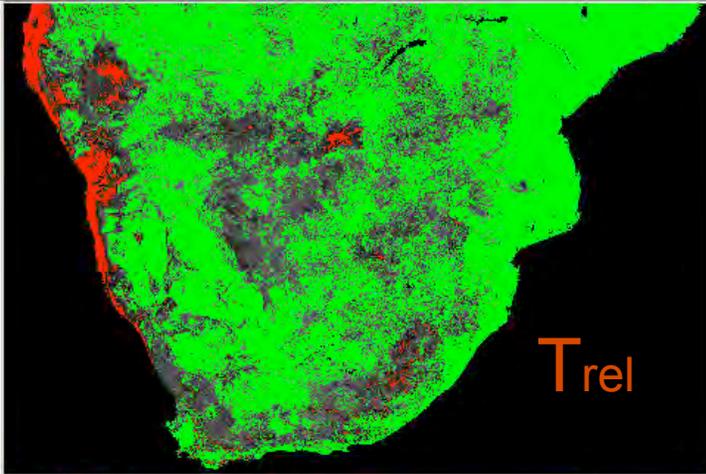
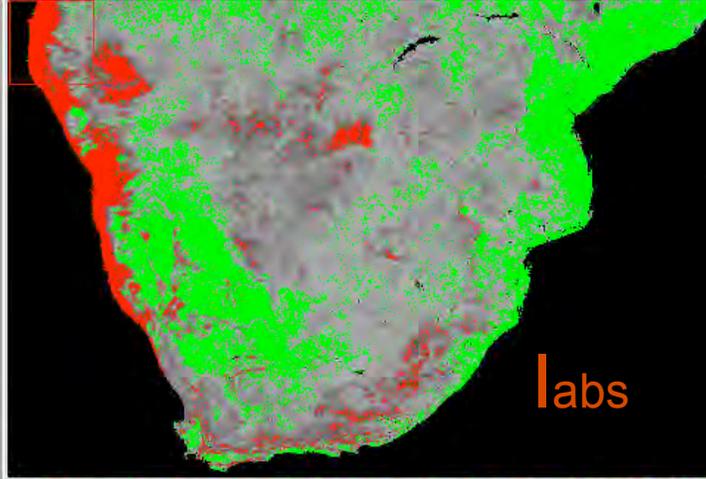
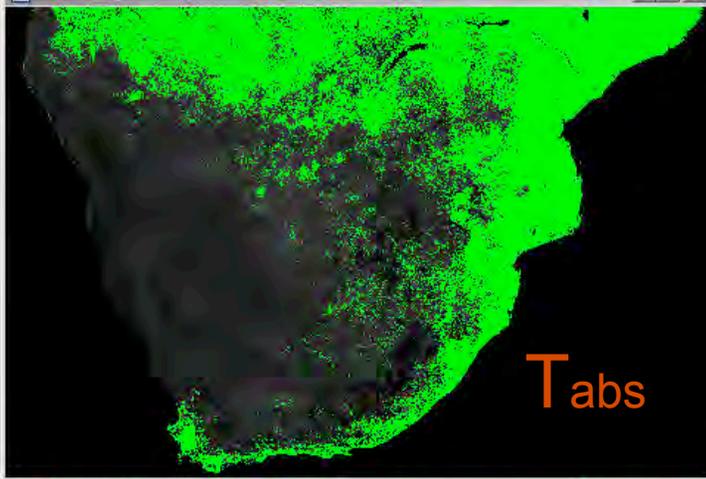
- NDVI is generally higher for VGT than for AVHRR sensors because of narrow width and exclusion of wavelength subject to water vapor
- NDVI difference between VGT and AVHRR sensors depend on surface that is measured – Polynomial correction coefficients is required for this relationship
- Relative correction shows better results than absolute comparison



Results

- Similar NDVI trend occurs for MODIS sensors as in the case of VGT – slightly higher NDVI values for green vegetation





$RMSE_{orig} - RMSE_{SRF}$

Lower RMSE

Higher RMSE

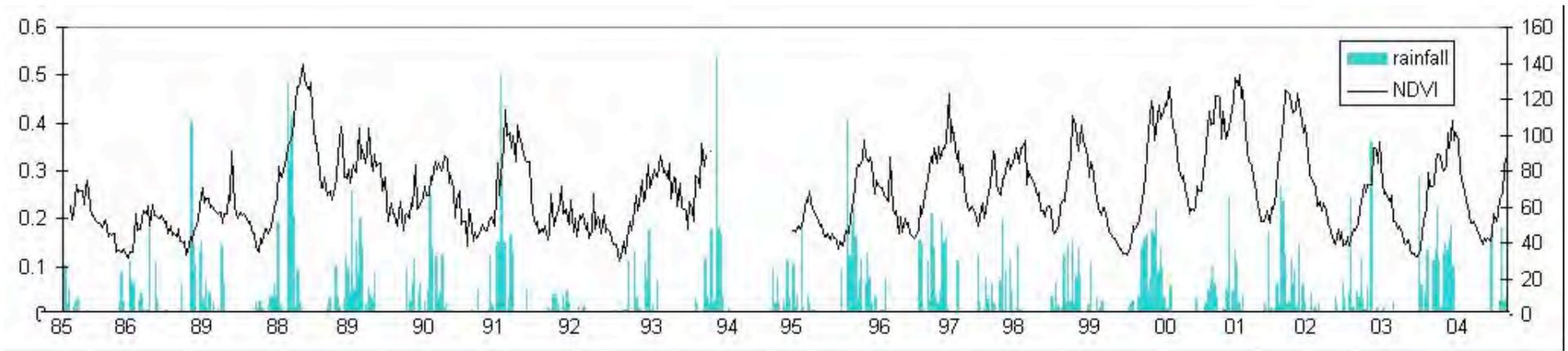
Conclusions

- SR correction functions are required to inter-calibrate between different sensors especially VGT & AVHRR, VGT & MODIS and AVHRR & MODIS
- Correction functions are not linear, but related to vegetation greenness
- Correction functions derived from Relative comparison between sensors provide higher R^2 values than Absolute comparison and should be used in inter-calibration



VGT time series 1985 – 2005

SRF corrections not applied



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Acknowledgement

- **GLOVEG-project:** scientific support of the **VEGETATION** instrument



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