INTEGRATION OF SENSORS APPLIED ON SOUTH AFRICAN ECOSYSTEMS (ISAFE)

Presented by Philip Frost

Main Authors: Else Swinnen & Karen Wentzel

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

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

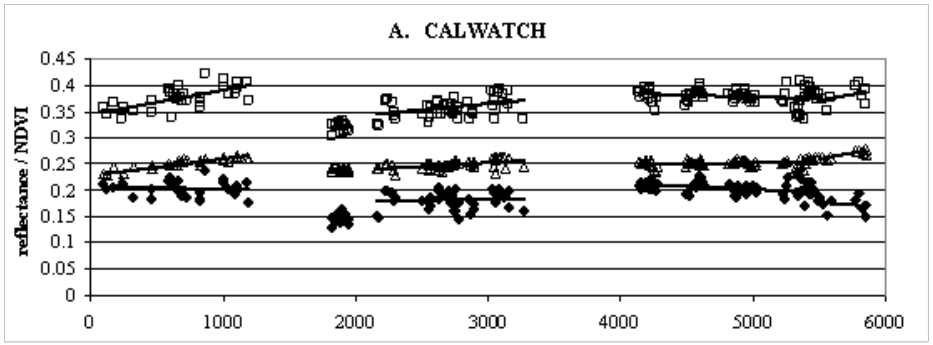
- Atmospheric correction (SMAC)
  - H2O: 6-hourly 1 degree measurements from ECMWF
  - O3: climatology based on TOMS data
  - Aod: empirical function
  - Interpolation of inputs in time and space
- Geometric accuracy:
  - mean RMSE: 1.04 pixels stdev 0.07 pixels
  - Resampling nearest neighbour
- MVC: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

our future through science

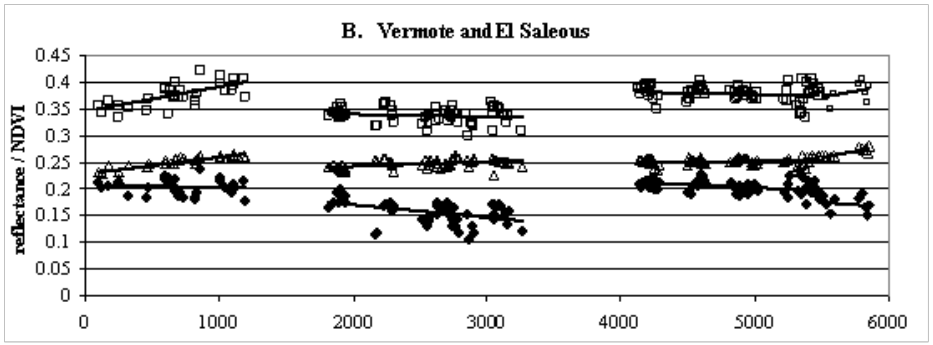
Calibration

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

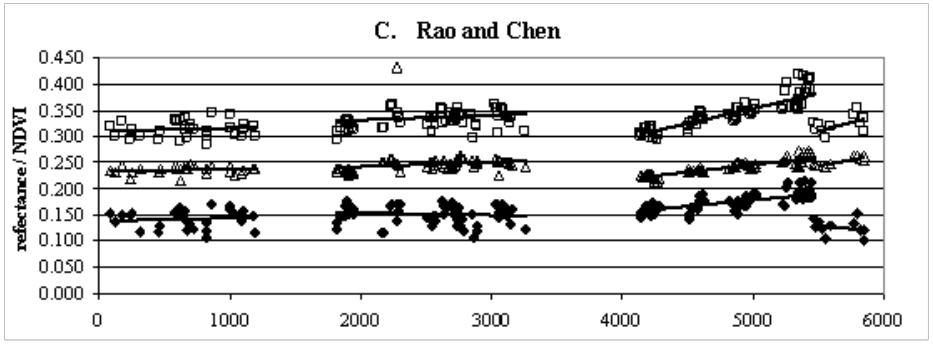
Vermote and El Saleous for NOAA-9 and NOAA-14, Mitchell for NOAA-11.As recommended by Calwatch



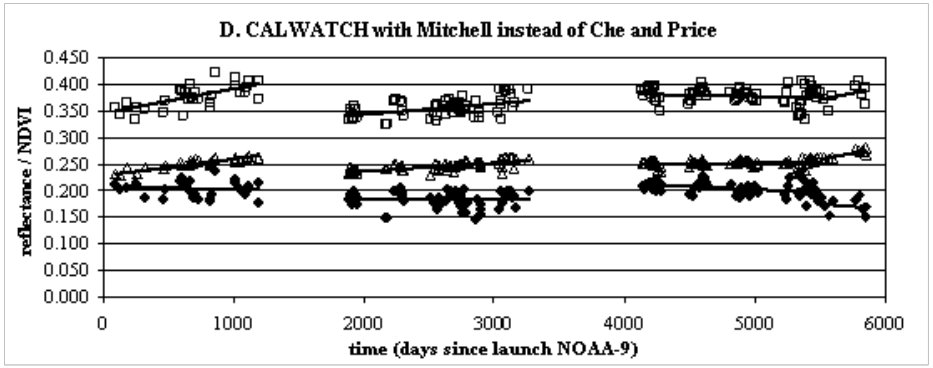
VES CP - MIT VES



VES VES VES



RC RC RC



VES MIT VES

our future through science

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.**

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**

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

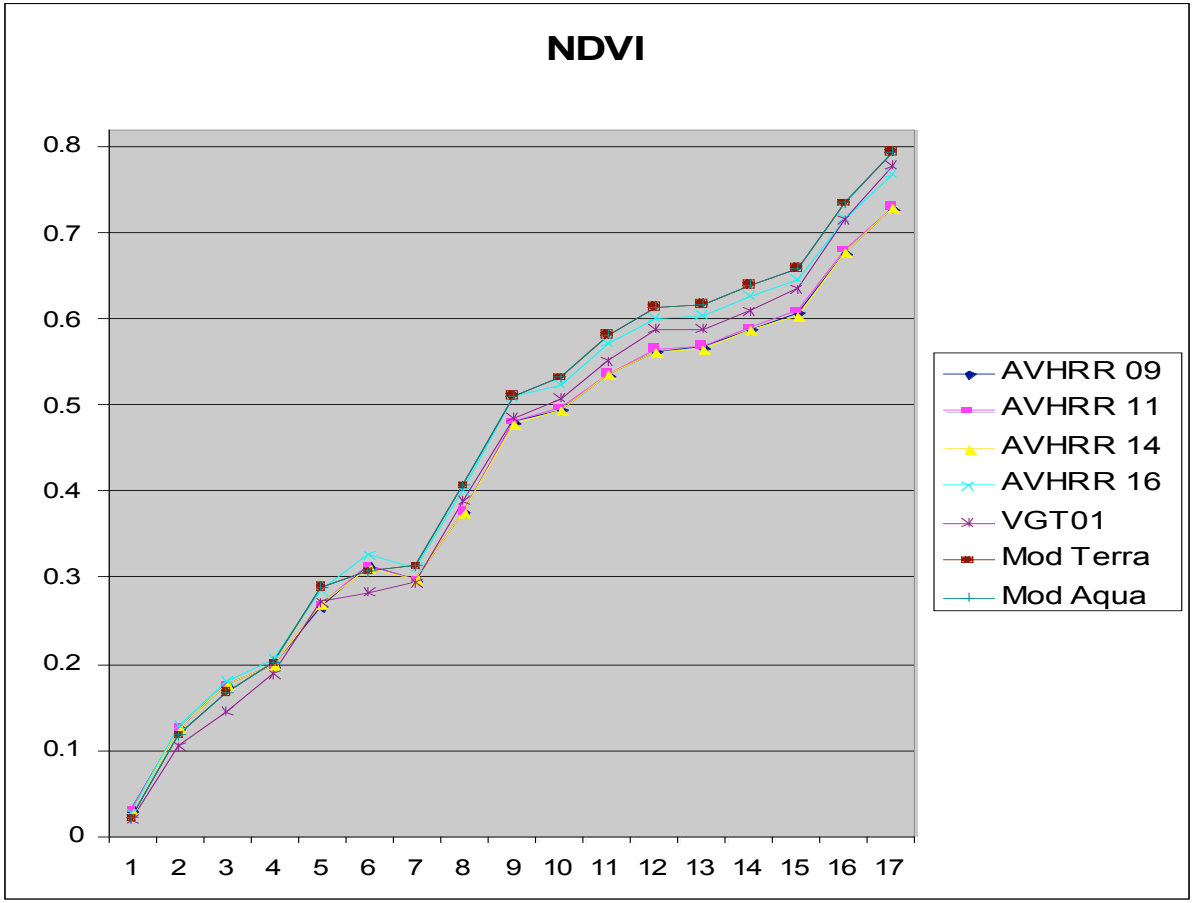
$$\overline{\rho} = \frac{\sum \omega_1 \rho_1 + \omega_2 \rho_2 + \omega_n \rho_n}{\Sigma \omega_n}$$

- Calculation of NDVI

$$NDVI = \frac{\overline{\rho}_{NIR} - \overline{\rho}_{\mathrm{Re}\,d}}{\overline{\rho}_{NIR} + \overline{\rho}_{\mathrm{Re}\,d}}$$

- 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

NDVI values calculated from simulated sensor responses



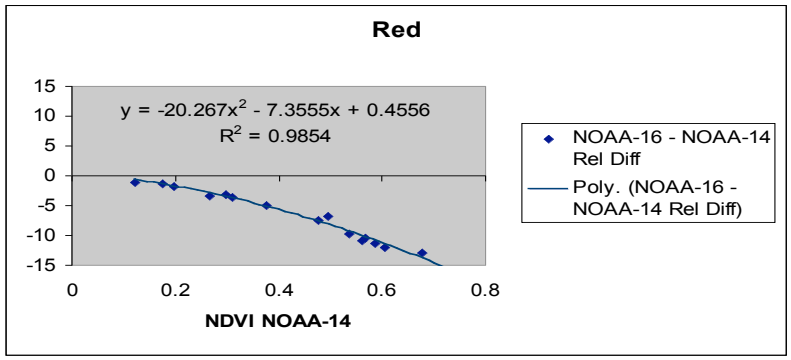
	ASD Sites
1	Bare Rock_site7
2	Bare Soil2_site8
3	Bare Soil1_site5
4	Oschrub_siteB1
5	OGrass2_siteB4
6	Degraded Woodland2_site6
7	Oschrub2_siteB2
8	OGrass1_siteB3
9	Dry Grass _site12
10	Dense Woodland_site3
11	Green Grass_site13
12	Young Grass_site14
13	Open Bushland2_site10
14	Open Woodland_site9
15	Pumpkin1_site4
16	White Maize_site15
17	Sugar cane_site11

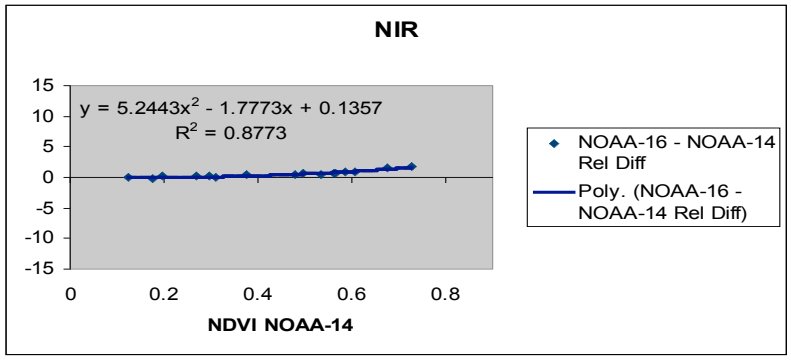
Methodological approach

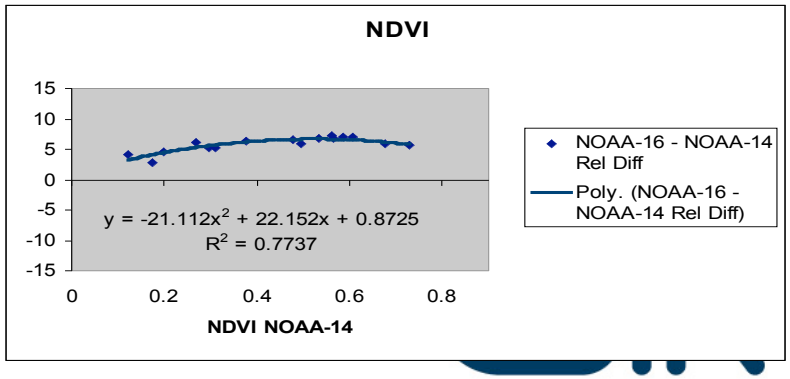
Steven *et al. 2003*	**Trischenko *et al. 2002***	**ISAFE**
Agricultural sites	Boreal region	Southern African Land Cover
SRF	SRF	SRF
ASD (Field)	Spectral curves form (ASTER & PROBE)	ASD (Field)
NDVI TOC	Red, NIR, NDVI TOC & TOA	Red, NIR,NDVI TOC
	Abs & Relative difference in relation to AVHRR-9	Abs &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

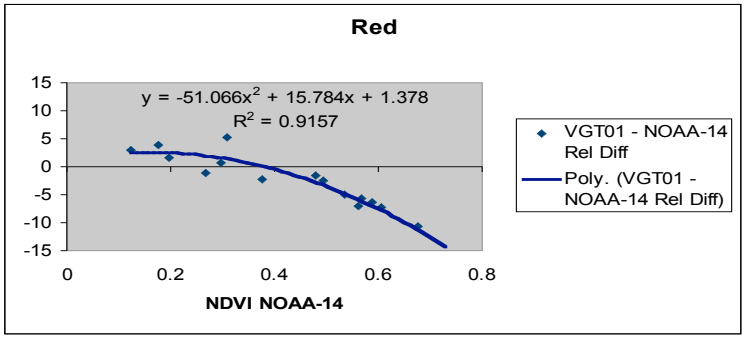


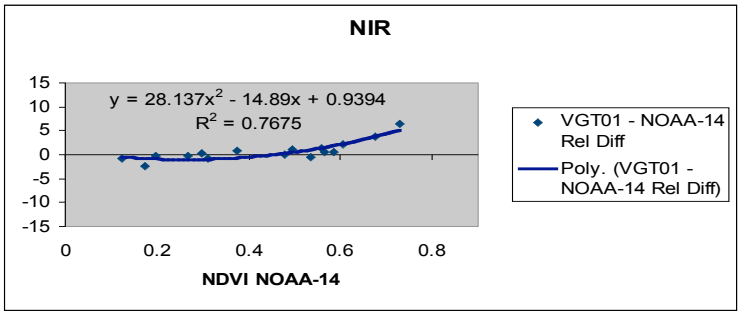


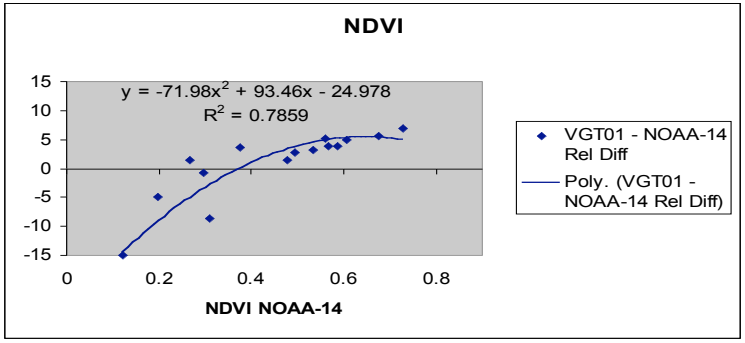


Results

- 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

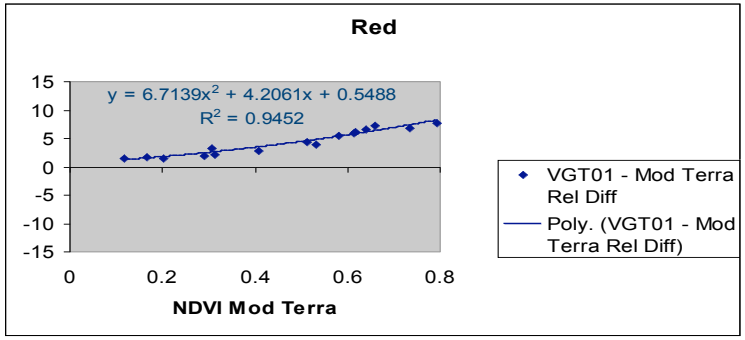


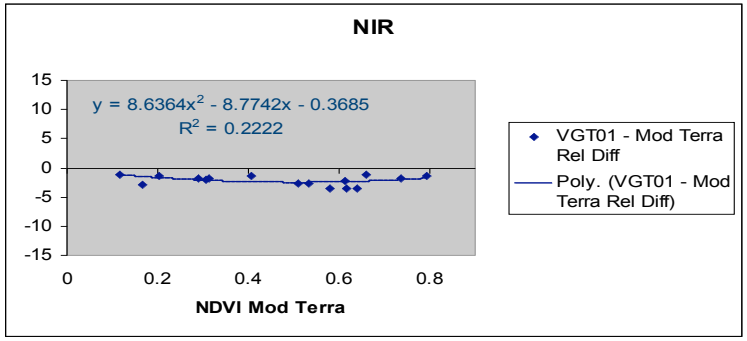


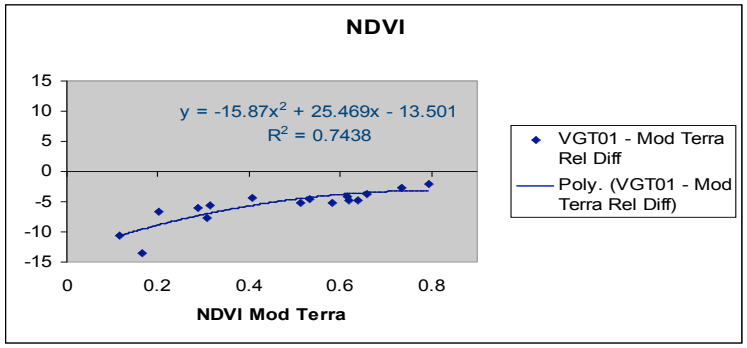


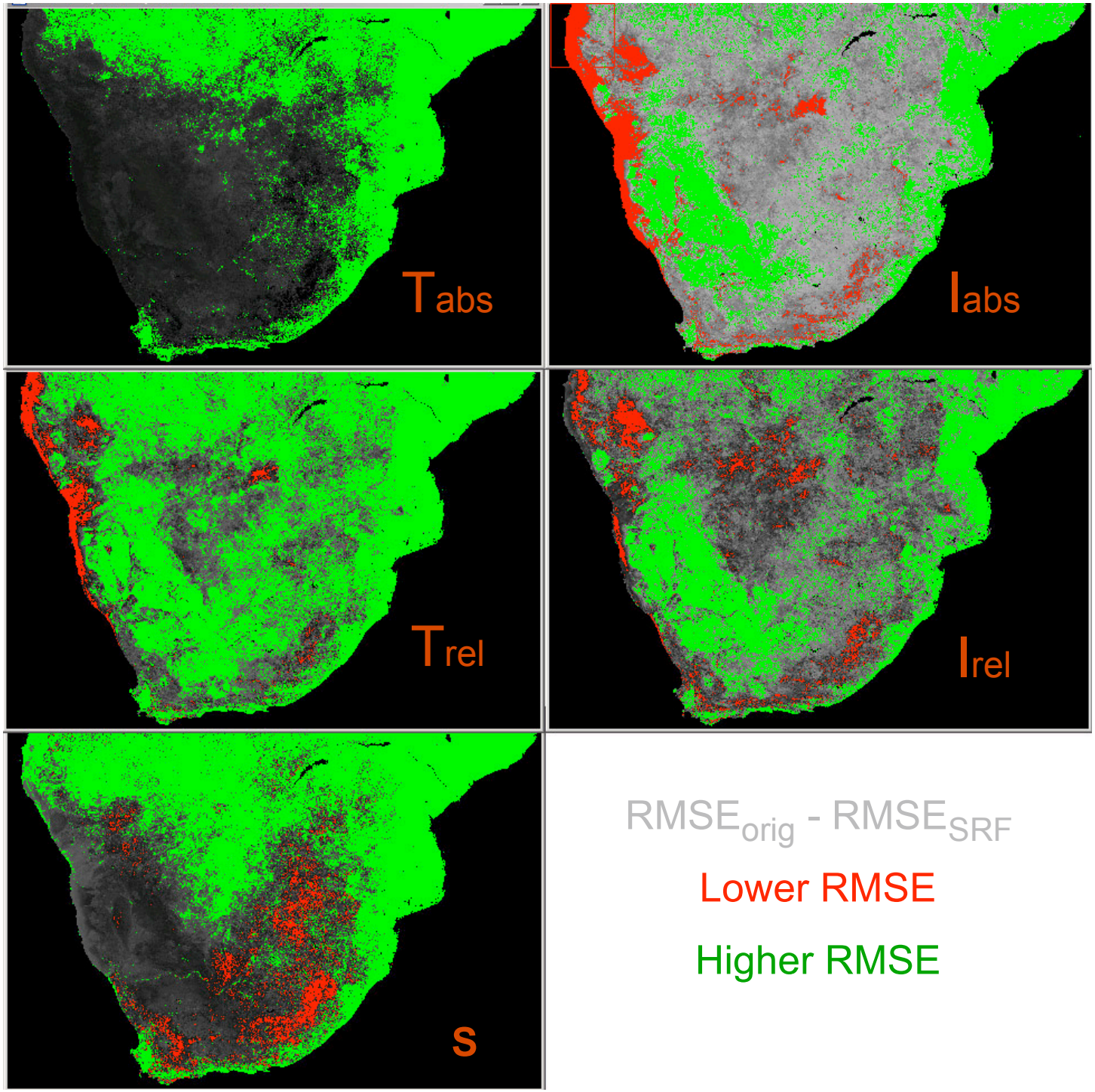
Results

- 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

our future through science

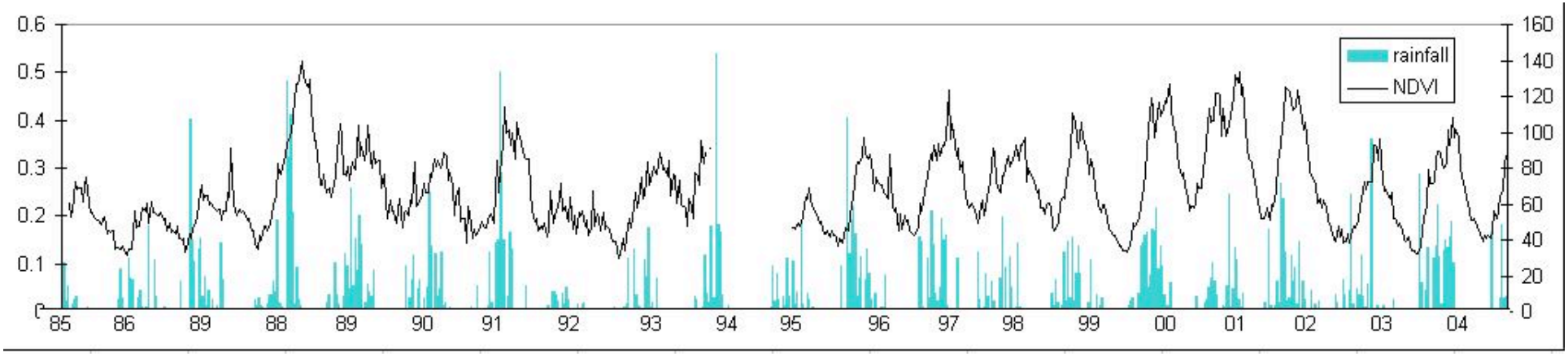
Conclusions

- 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

our future through science

VGT time series 1985 – 2005

SRF corrections not applied



our future through science

Acknowledgement

- GLOVEG-project: scientific support of the VEGETATION instrument

our future through science