

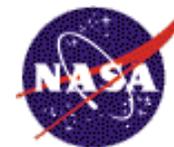
AVHRR LTDR

Burned Area

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Geographic Information Science Center of Excellence

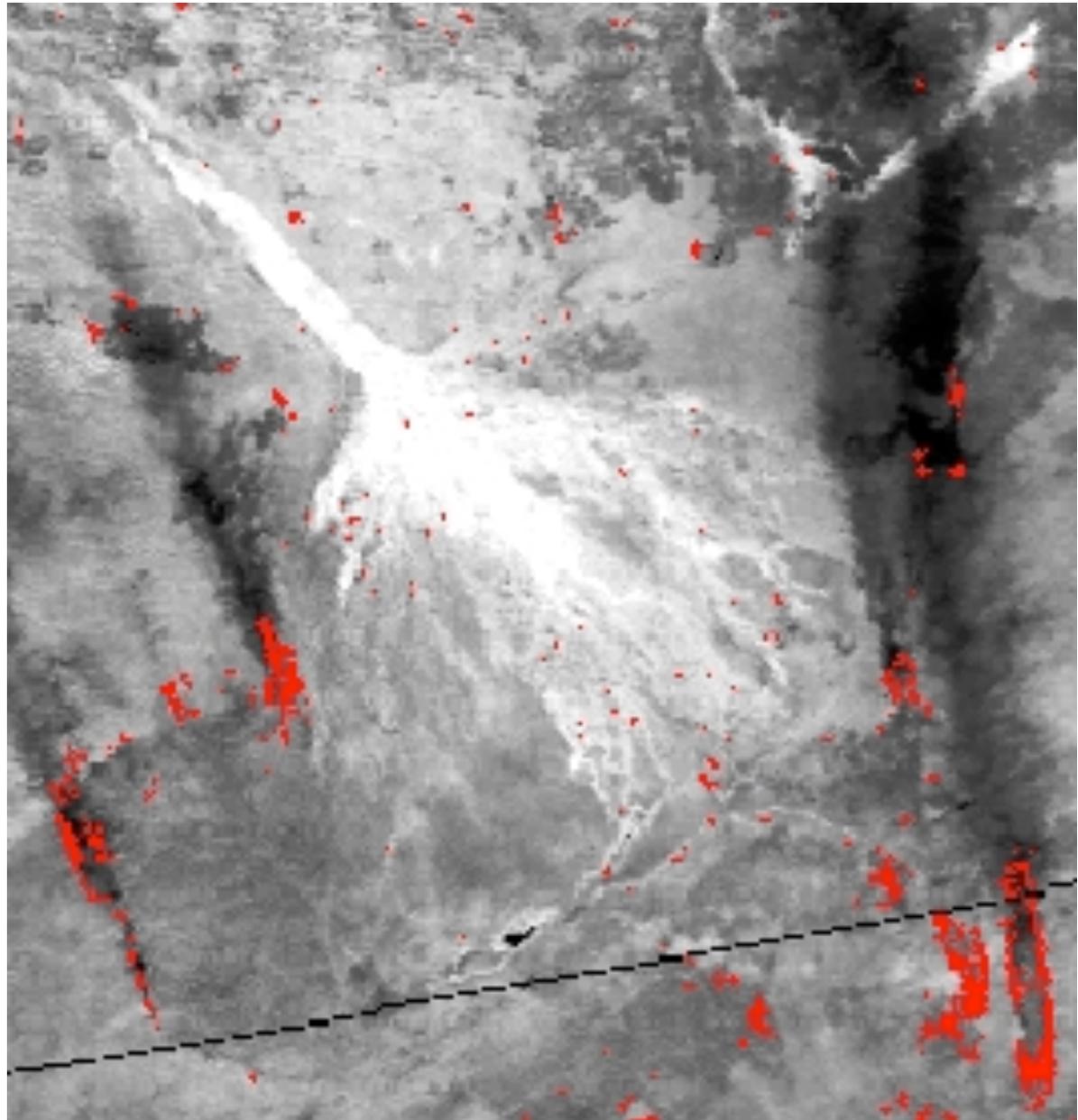
January 18th 2007



Heritage:

burned area
statistics estimated
from active fire
detections:
simple counts
or calibration

AVHRR active fires (red)
on NDVI
Okavango Delta,
Botswana,
September 6th 1989



Our analysis also highlights shortcomings in the currently available processed AVHRR record and current generation of global burn scar detection algorithms. Improvements in both areas should lead to more reliable measures of actual area burned, to complement the existing capability, as reported here, concerning characterization of location and timing of major fire events.

1544 C. CARMONA-MORENO *et al.*

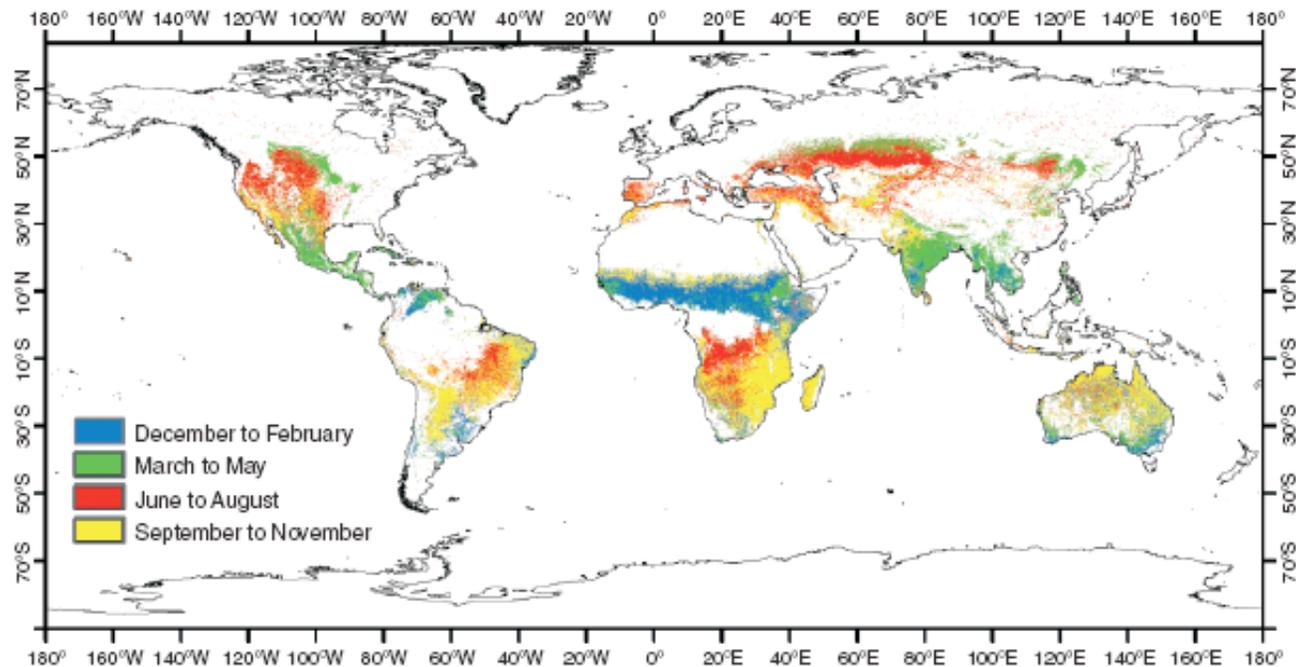


Fig. 4 Global fire activity seasonal cycle. This figure represents the seasonal distribution of the fire activity obtained from the accumulated spatial-temporal distribution of the global burnt surface products for the period 1982–1999.

Characterising interannual variation in global fire calendar using data from Earth Observing satellites, Carmona-Moreno, C., Belward, A., Malingreau, J.P., Hartley, A., Garcia-Alegre, M., Antonovskiy, M., Buchshtaber, V., Pivovarov, V. **2005**. *Global Change Biology*. **11**(9), 1537-1555

Large Area Mapping Issues

- Spectral, Spatial, Temporal characteristics of burned areas differ as a function of the
 - **pre-fire**: vegetation, soil, composition & structure
 - **fire behavior**: combustion completeness, sub-pixel fraction burned, ash/charcoal reflectance, surface/crown fire
 - **post-fire**: vegetation regrowth/mortality, char/ash dissipation
- At reflective wavelengths burned areas can be confused spectrally with non-burning phenomena
 - cloud & relief shadow
 - wet and flooded surfaces
 - agricultural harvesting, deforestation
 - snow melt
 - certain types of rapid veg. senescence
- At thermal wavelengths difficult to robustly differentiate burned from unburned surfaces due to the numerous processes controlling emitted radiation, diurnal variations of these, and emissivity variability

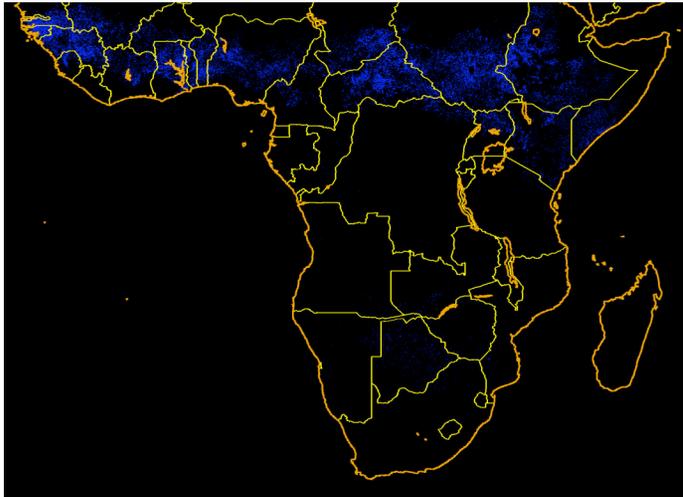
Mapping Methodologies

- Definition of the magnitude of spectral *change* associated with the conversion of vegetation to burned vegetation is **critical**.
- Thresholds have been defined by
 - examination of the frequency distribution of the data used to map burning (Barbosa *et al.*, 1999, Carmona *et al.* 2005)
 - comparison of the data used to map burning with contemporaneous active fire detection results (Roy *et al.*, 1999; Fraser *et al.*, 2000)
 - classification tree approaches (Stroppiana *et al.*, 2002; Silva *et al.*, 2002)
 - use of a semi-empirical reflectance model and statistical measure to detect change from a previously observed state (Roy *et al.*, 2005)

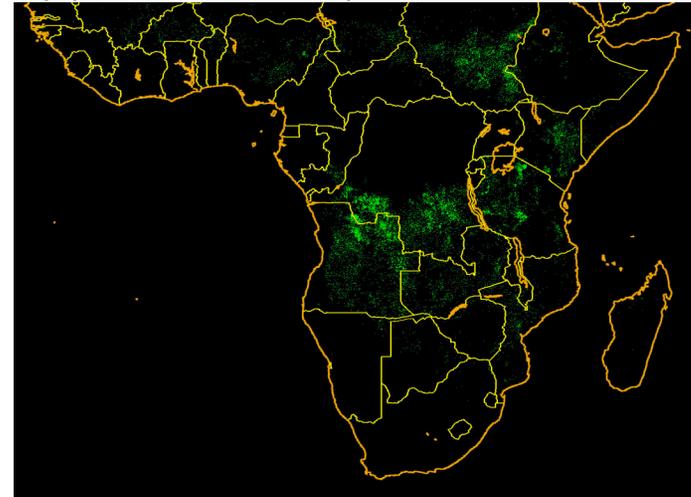
AVHRR 5km Burned Areas

Barbosa et al. 1999 (JRC)

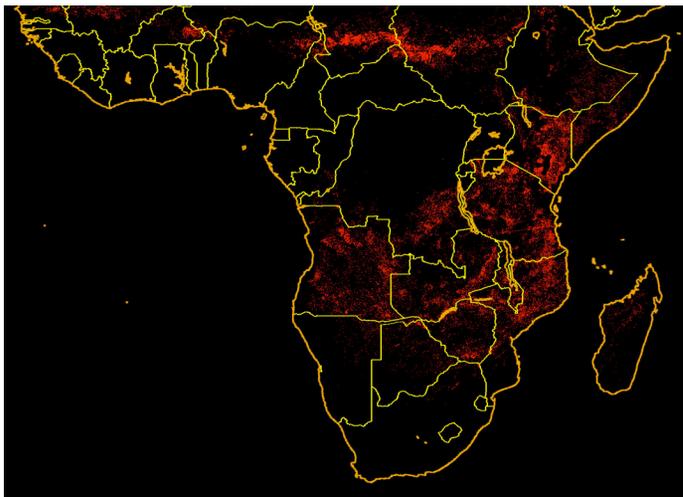
(decrease in VI, increase in apparent temperature)



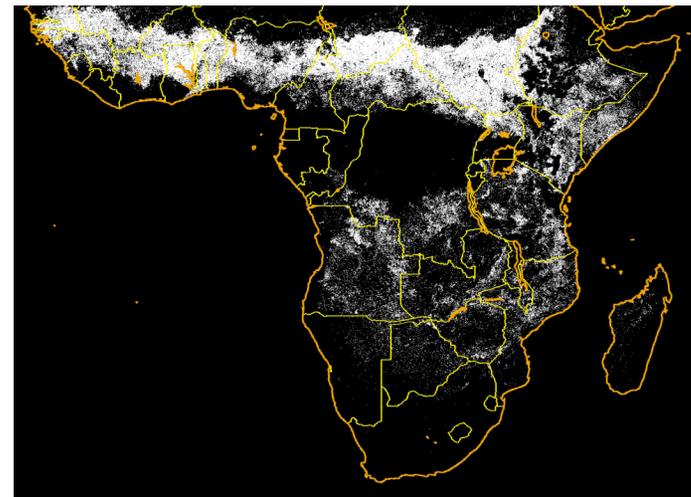
February - April 1987



May - July 1987



August - October 1987



November 1986 - October 1987

(Paulo Barbosa)

GLOBCARBON SPOT-ATSR-MERIS (ESA)

GBA-2000 (JRC)

Globscar (ESA)

- Original = 6 regional algorithms
- GLOBCARBON = 1 global and 2 regional algorithms
- it has associated with it confidence information (detection confidence from individual algorithms)

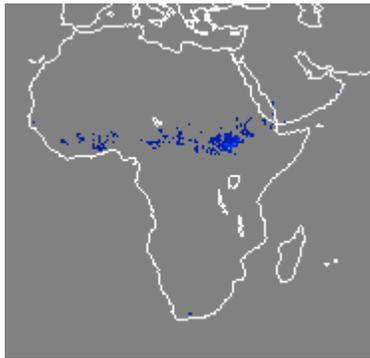
- Original = 2 global algorithms and burn when both agree.
- GLOBCARBON = each algorithm and sub-parts given a probability.
- The resulting probability determines occurrence of a pixel as burned (confidence information)

- Results are merged into one 1km product
- Collocation with available active fire products improves confidence

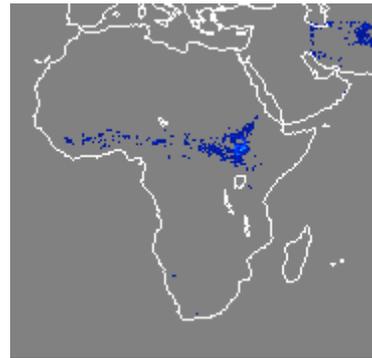
(S. Plummer)

GLOBCARBON January

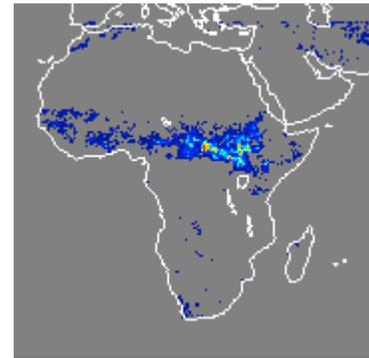
1998



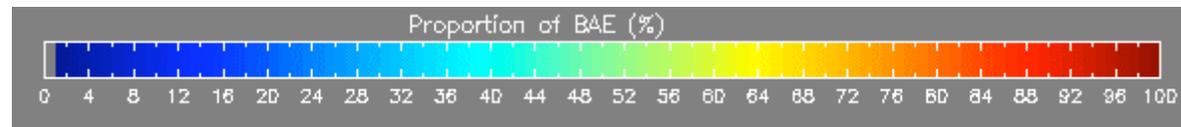
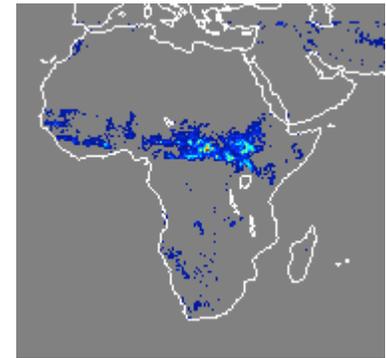
1999



2000



2001



Current version, regionally implausible overestimates of area burned

(Olivier Arino)

What is Promising about the LTDR for Burned Area Mapping

- State of the practice AVHRR pre-processing
 - Calibration
 - Geometric Correction
 - Atmospheric Correction
 - Cloud Screening
 - *Consistency cross the NOAA AVHRR series*
- New, AVHRR LTDR products
 - Reflective component of the middle infrared
 - Surface temperature

NDVI, 6 September 1989
NOAA-11 AVHRR 1.1 km pixels



360 x 360km

VI3, 6 September 1989

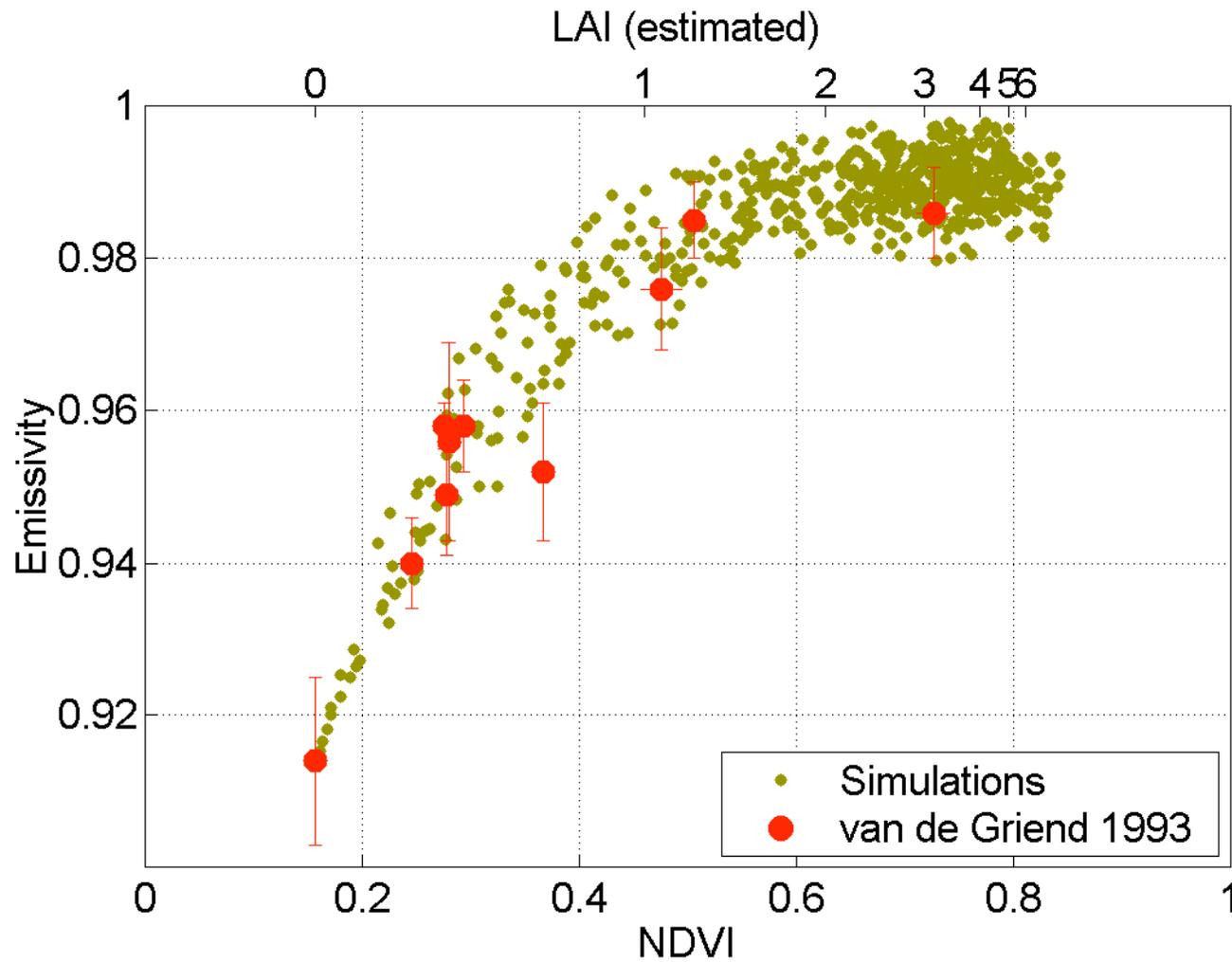
NOAA-11 AVHRR 1.1 km pixels

$$VI3 = (\rho_2 - \rho_3) / (\rho_2 + \rho_3)$$



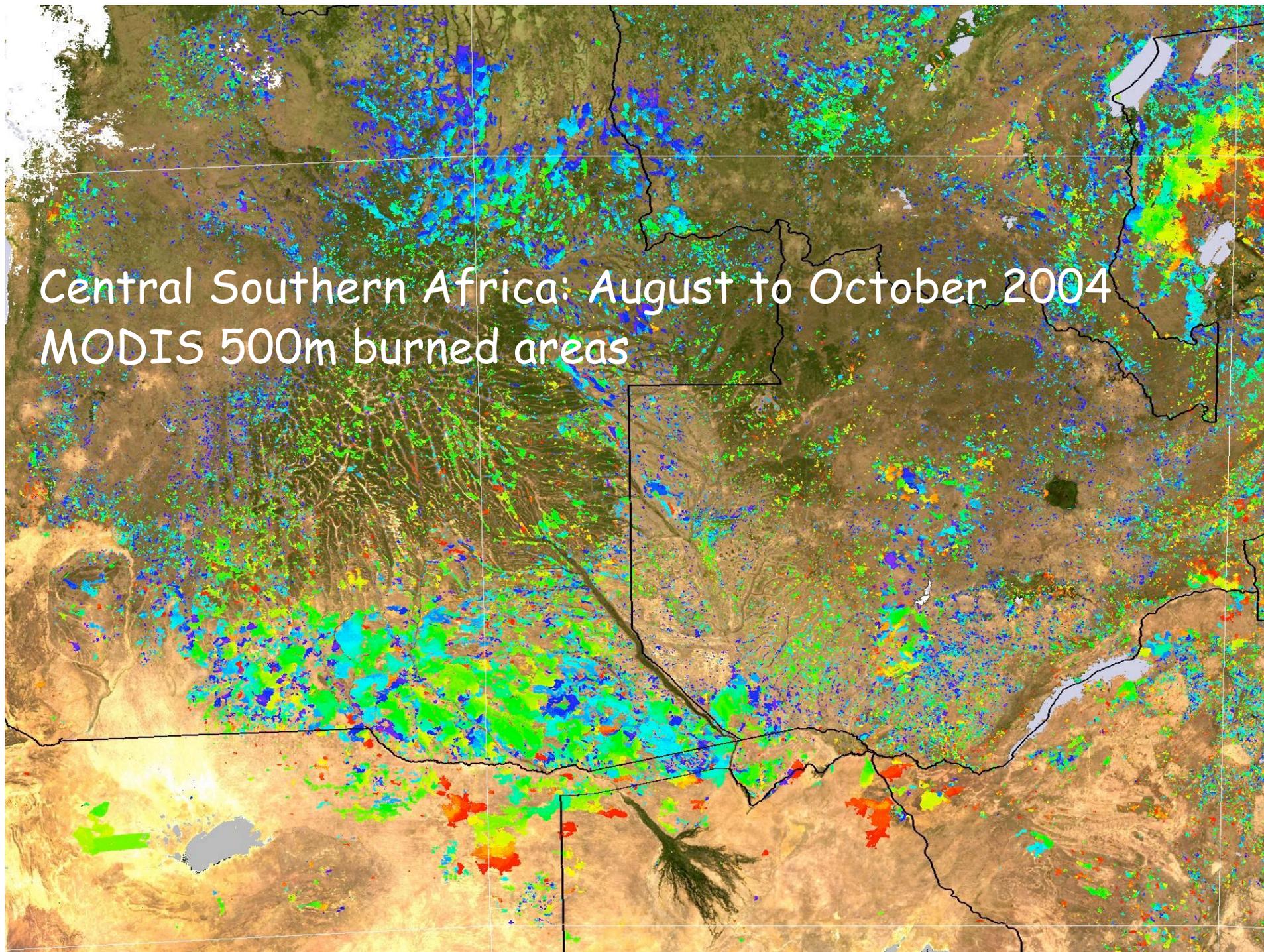
360 x 360km

van de Griend and Owe 1993 (8-14 μm)



(A. Olios)

Central Southern Africa: August to October 2004
MODIS 500m burned areas



10 ten day max. BT3 composites
BT3: 191-290, 201-210, ..., 281 - 290



1999 AVHRR LTDR

Animation contrast stretch:
black=295K, white=320K

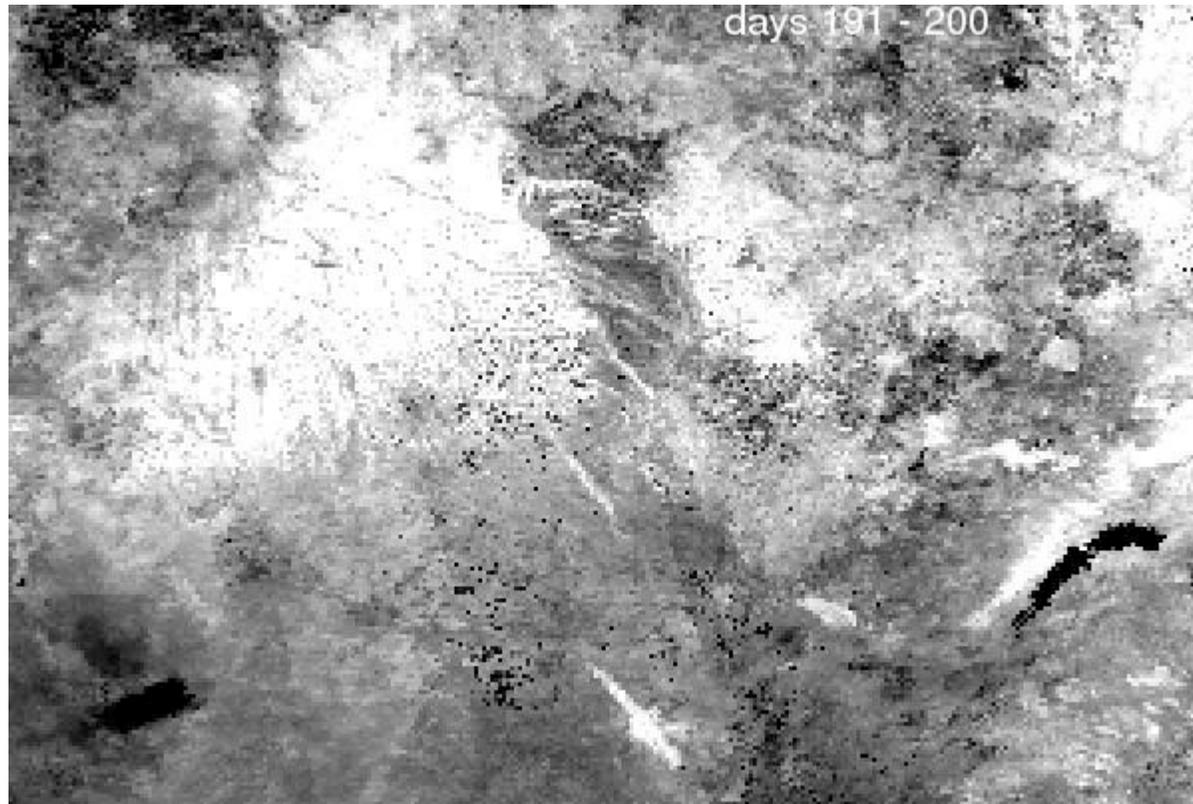
91 rolling ten day max. BT3 composites
BT3: 191-290, 192-291, ...281 - 290



1999 AVHRR LTDR

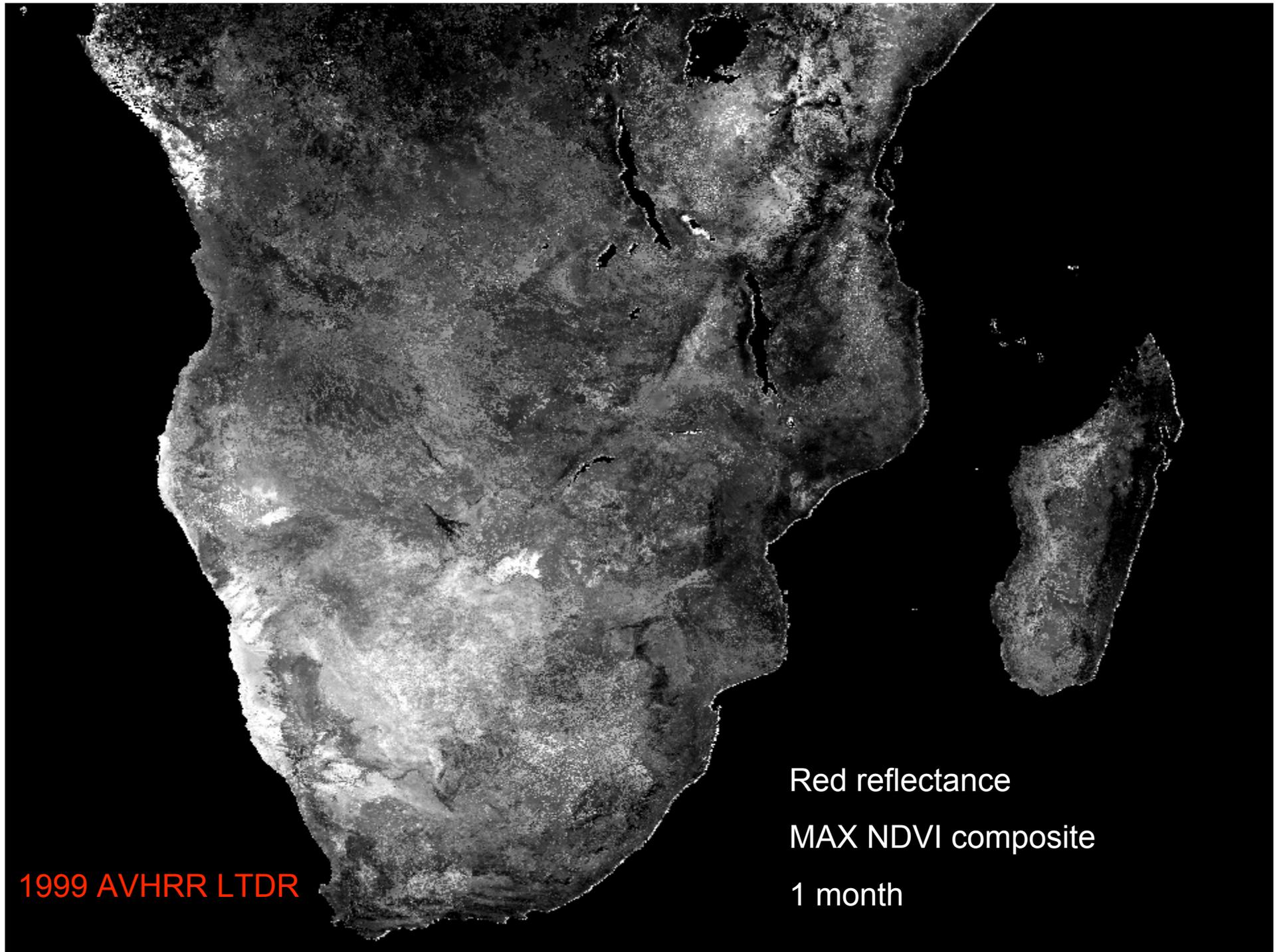
Animation contrast stretch:
black=295K, white=320K

91 rolling ten day max. NDVI composites
NDVI: 191-290, 192-291, ...281 - 290



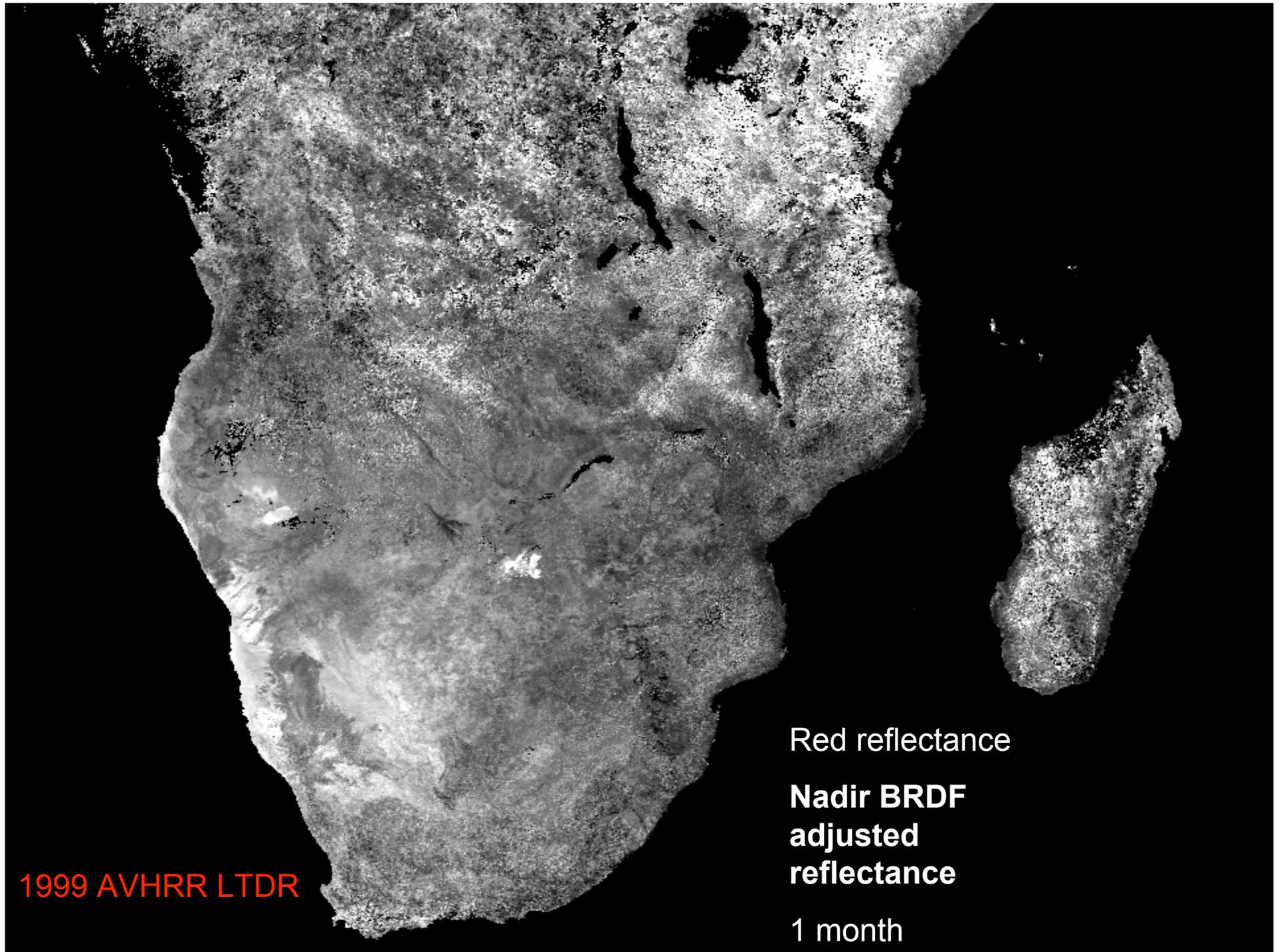
1999 AVHRR LTDR

Animation Contrast stretch:
black=0.12, white=0.46



1999 AVHRR LTDR

Red reflectance
MAX NDVI composite
1 month

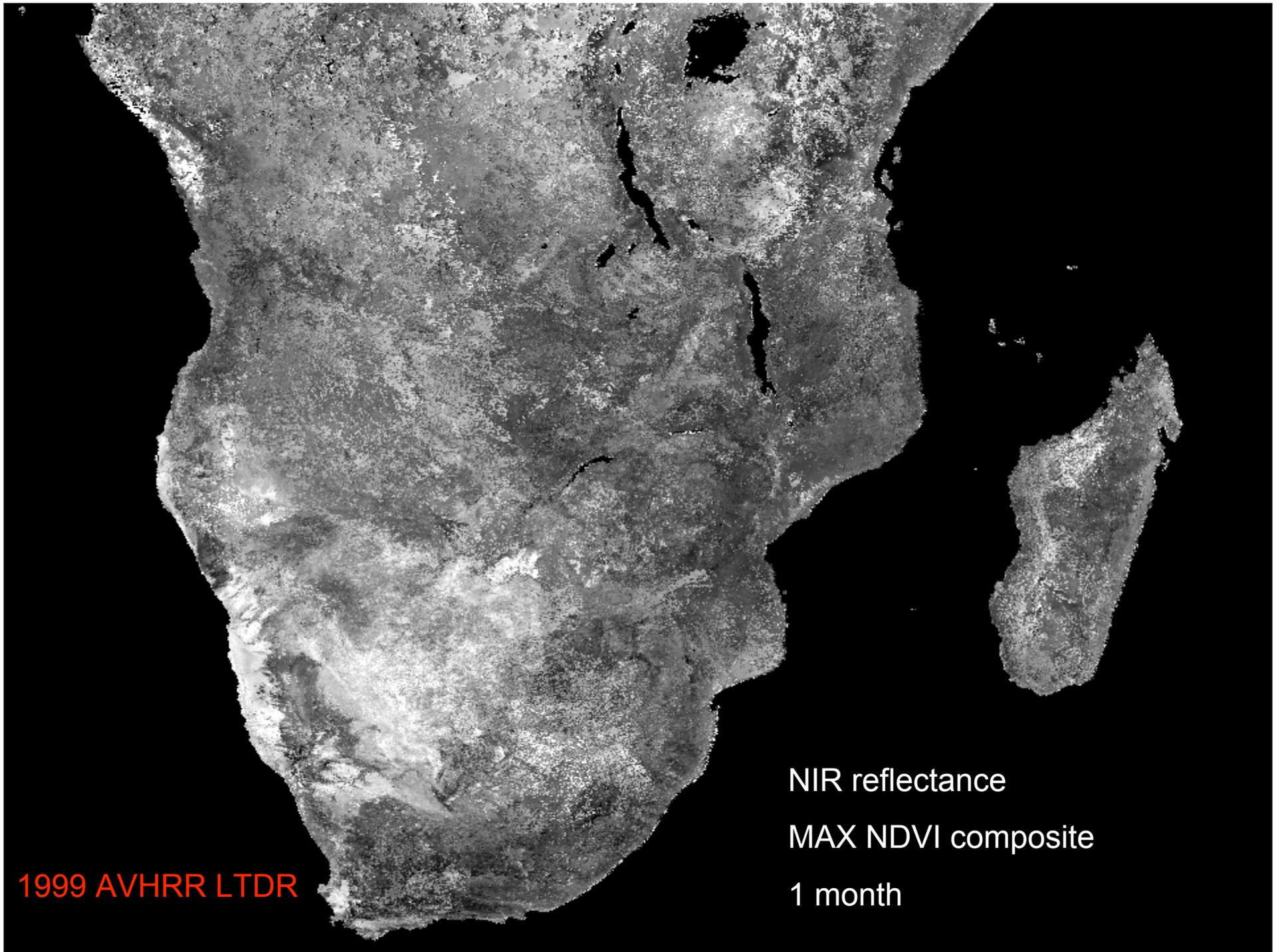


1999 AVHRR LTDR

Red reflectance

**Nadir BRDF
adjusted
reflectance**

1 month

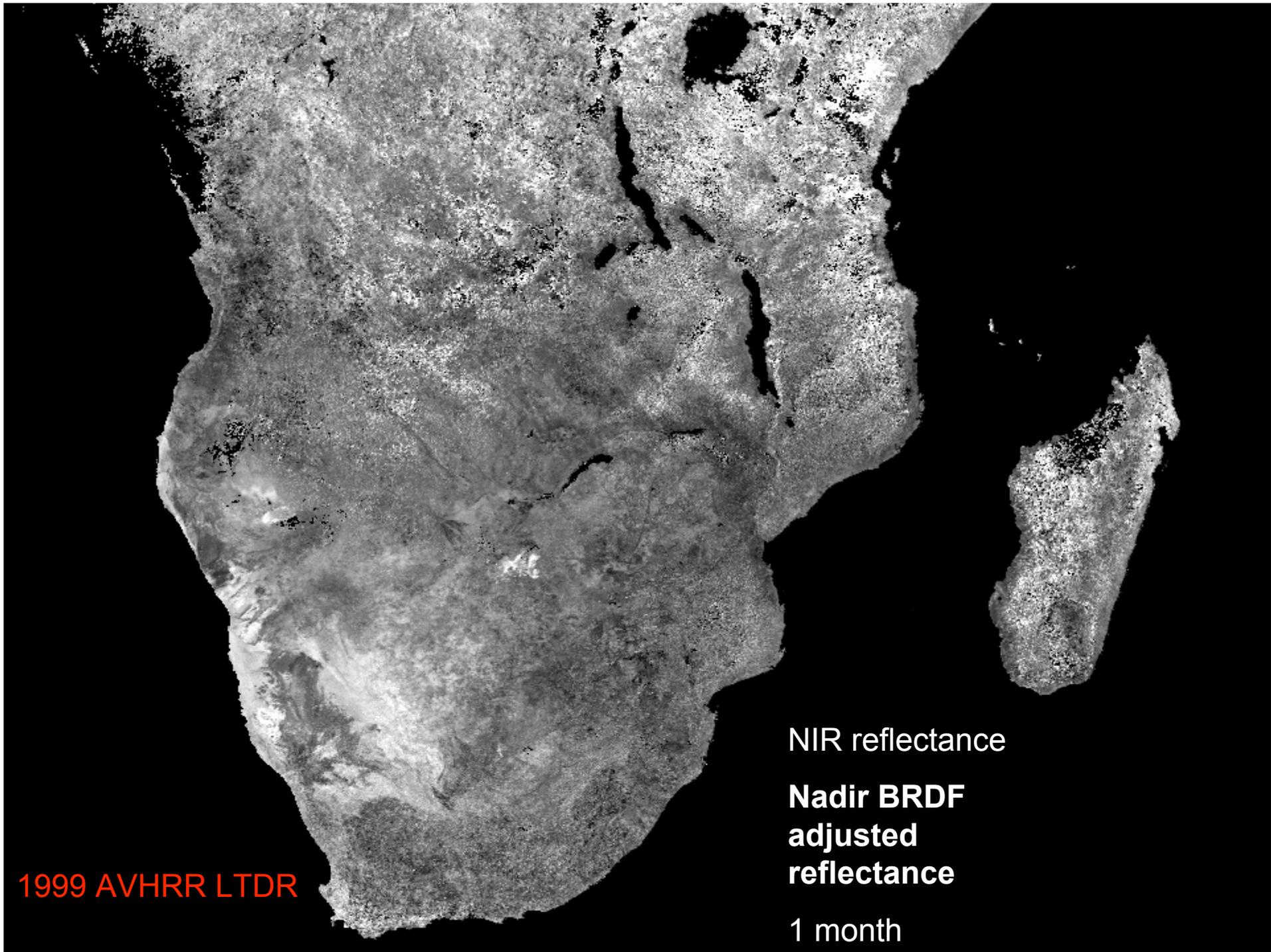


1999 AVHRR LTDR

NIR reflectance

MAX NDVI composite

1 month

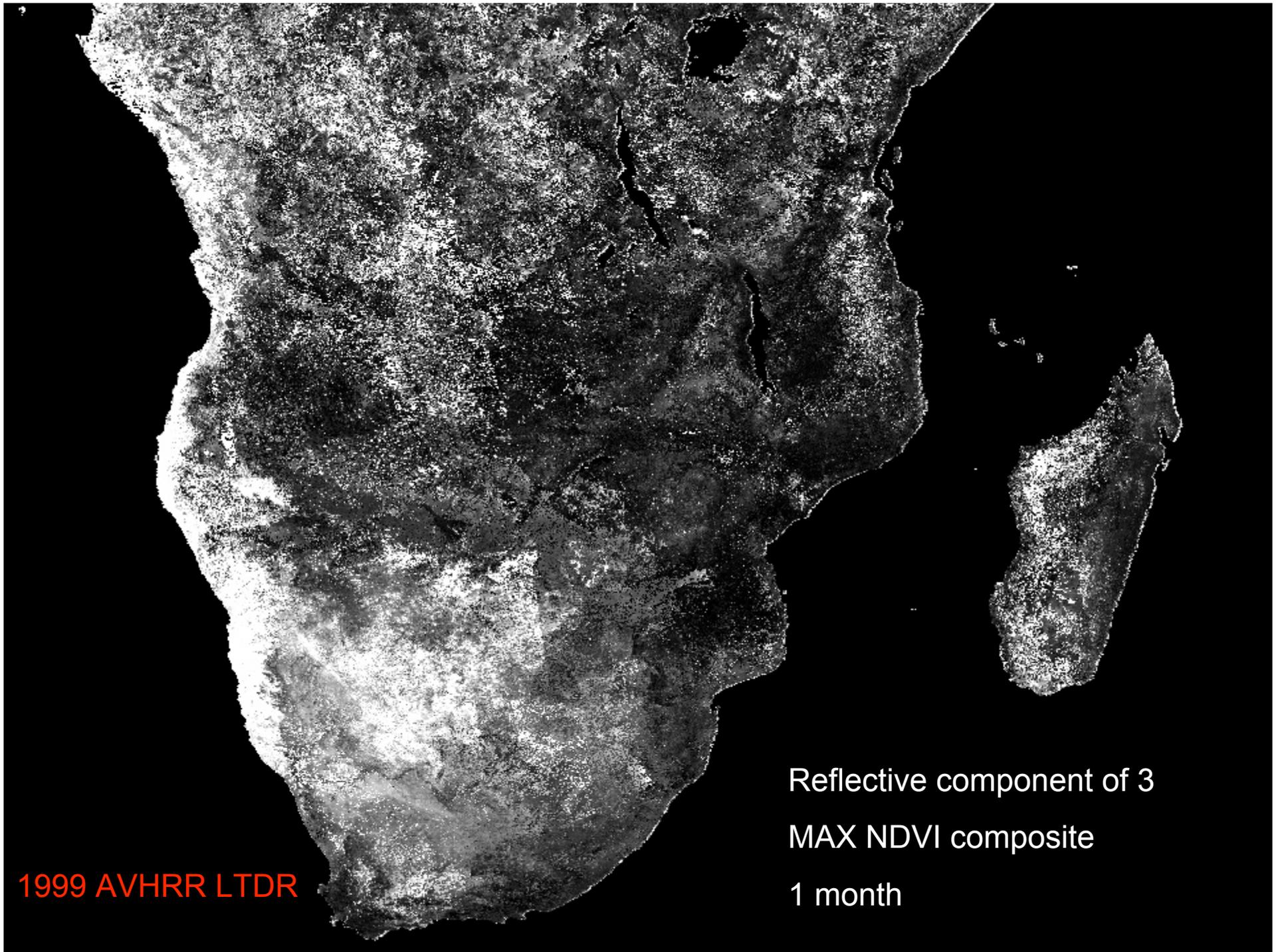


1999 AVHRR LTDR

NIR reflectance

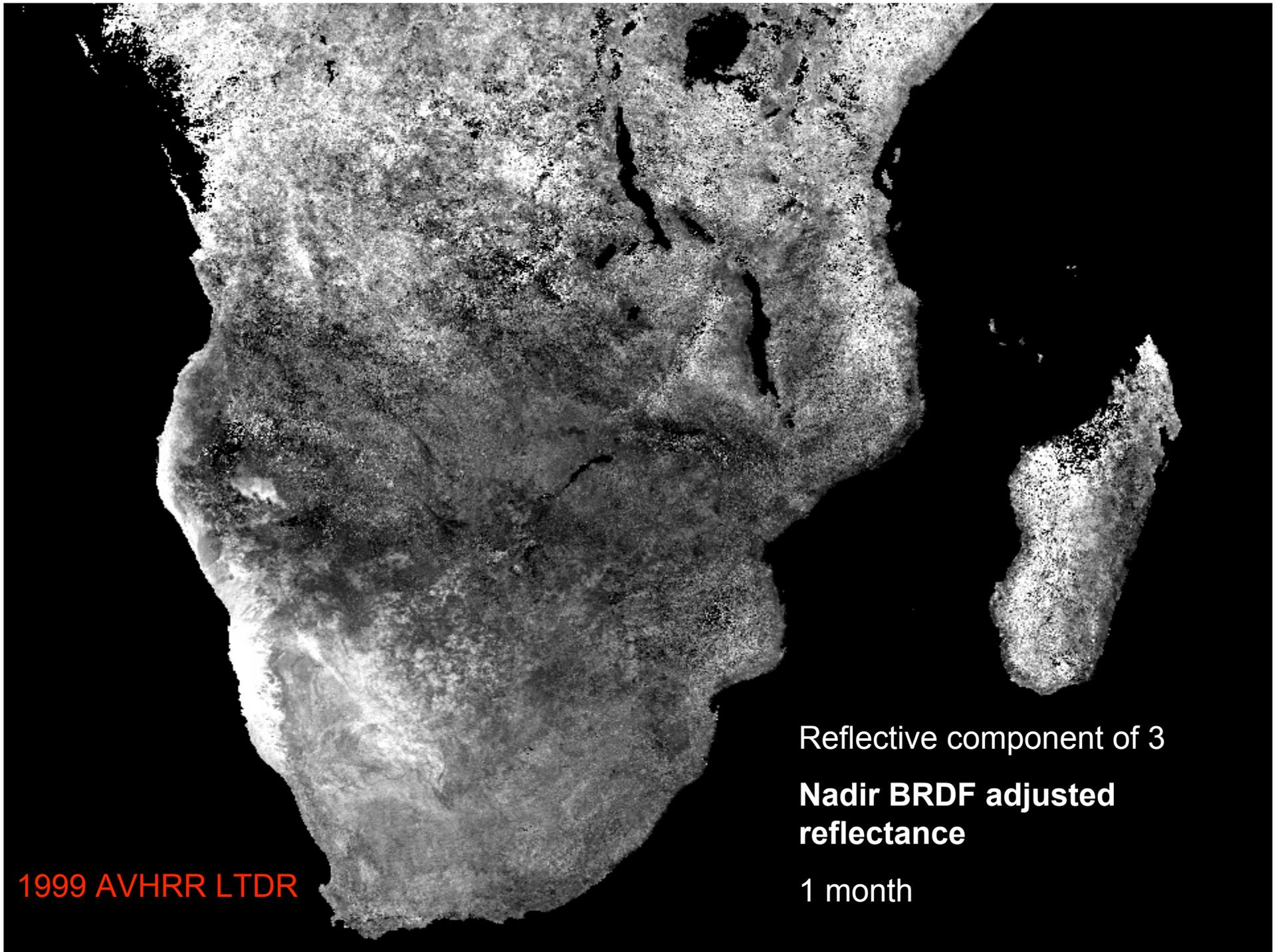
**Nadir BRDF
adjusted
reflectance**

1 month



1999 AVHRR LTDR

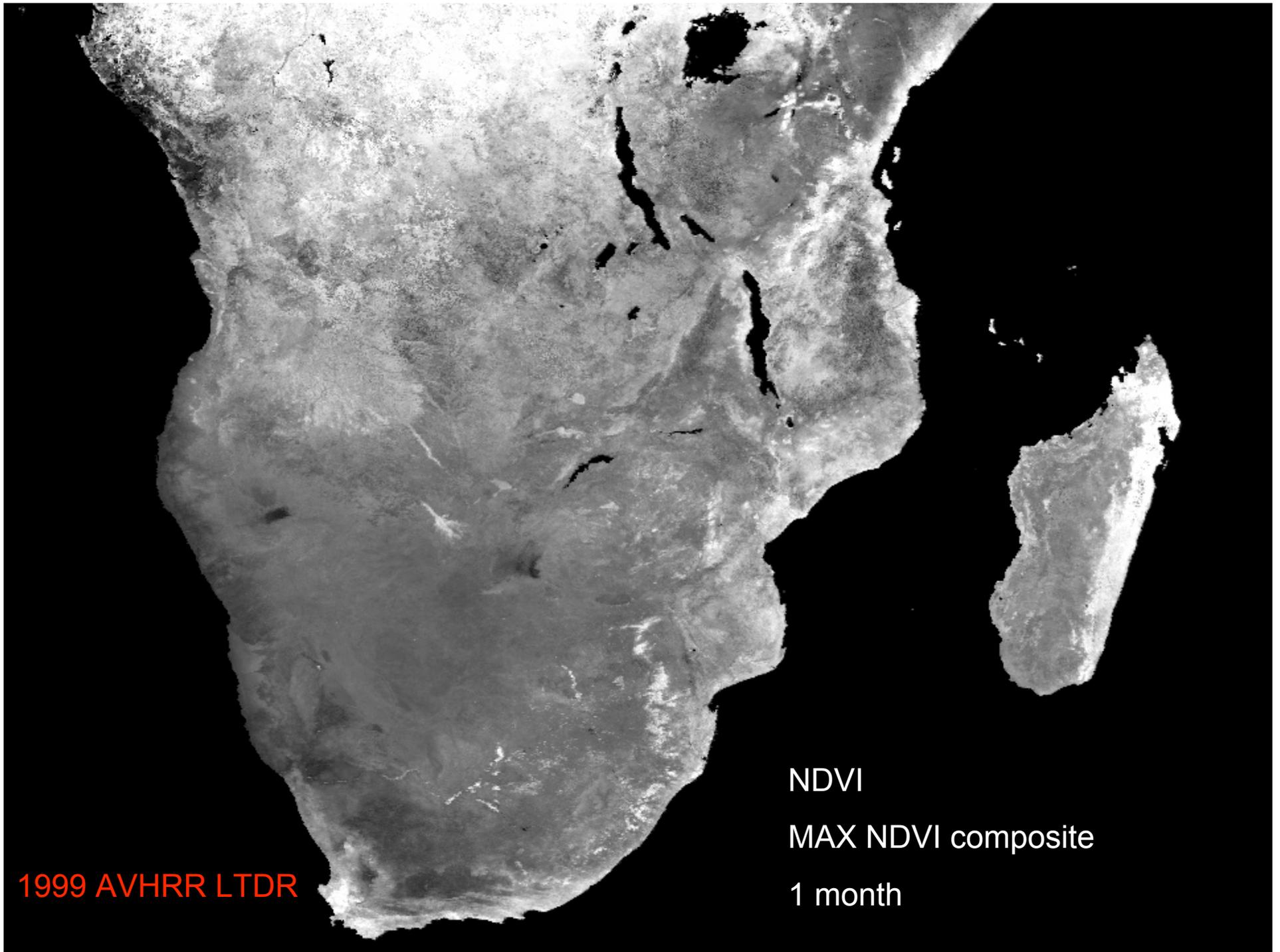
Reflective component of 3
MAX NDVI composite
1 month



1999 AVHRR LTDR

Reflective component of 3
**Nadir BRDF adjusted
reflectance**

1 month

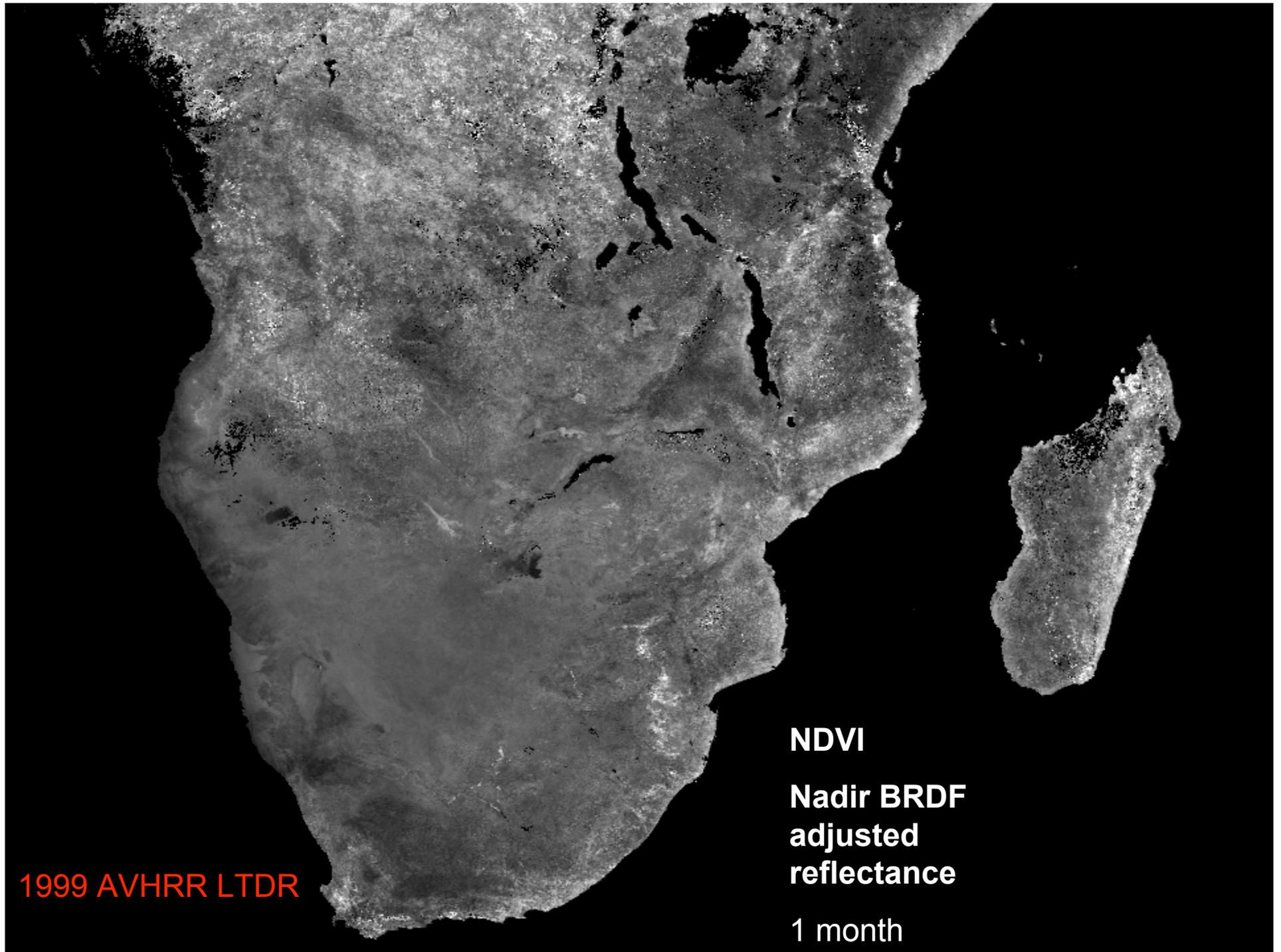


1999 AVHRR LTDR

NDVI

MAX NDVI composite

1 month

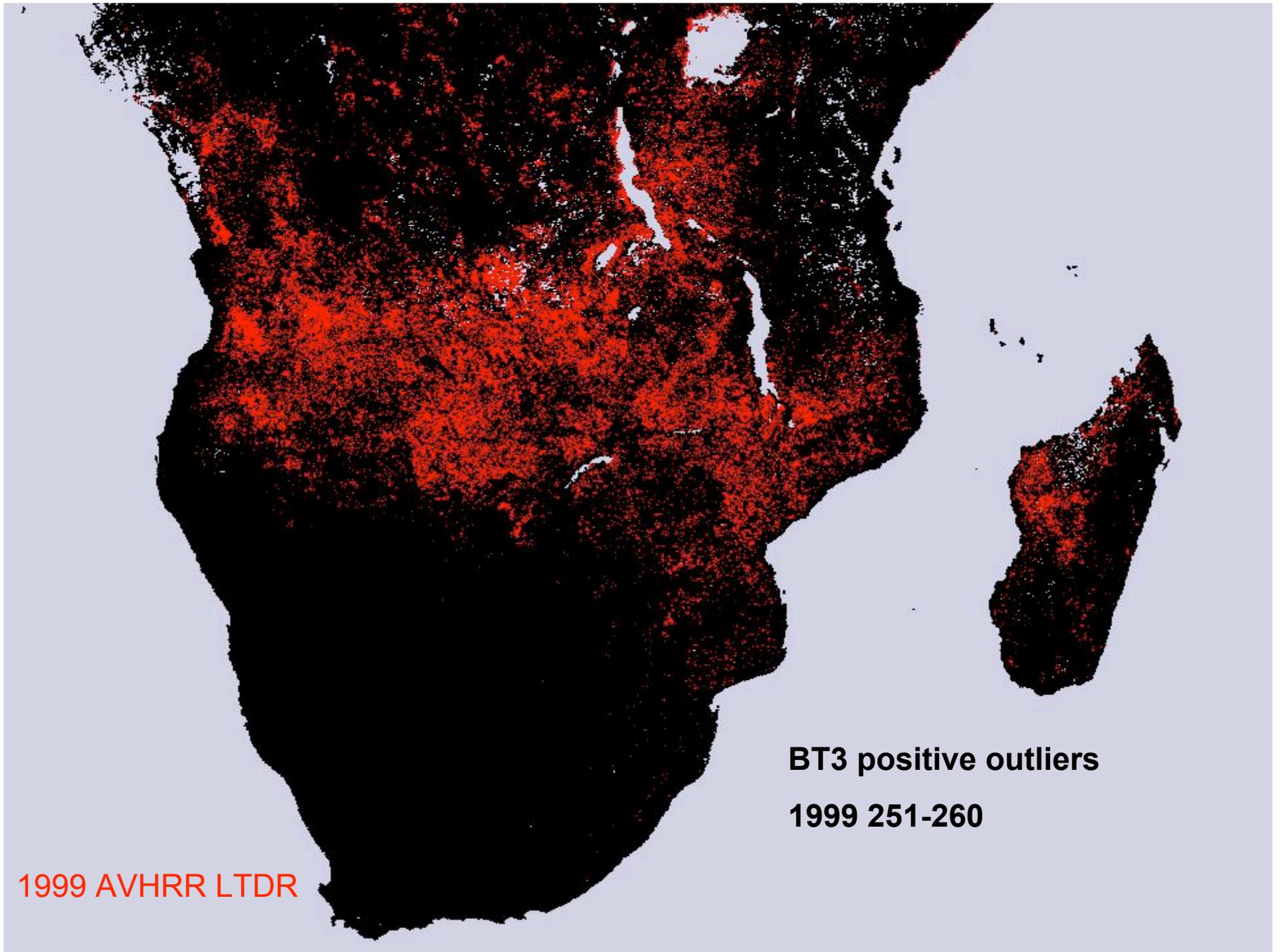


1999 AVHRR LTDR

NDVI

Nadir BRDF
adjusted
reflectance

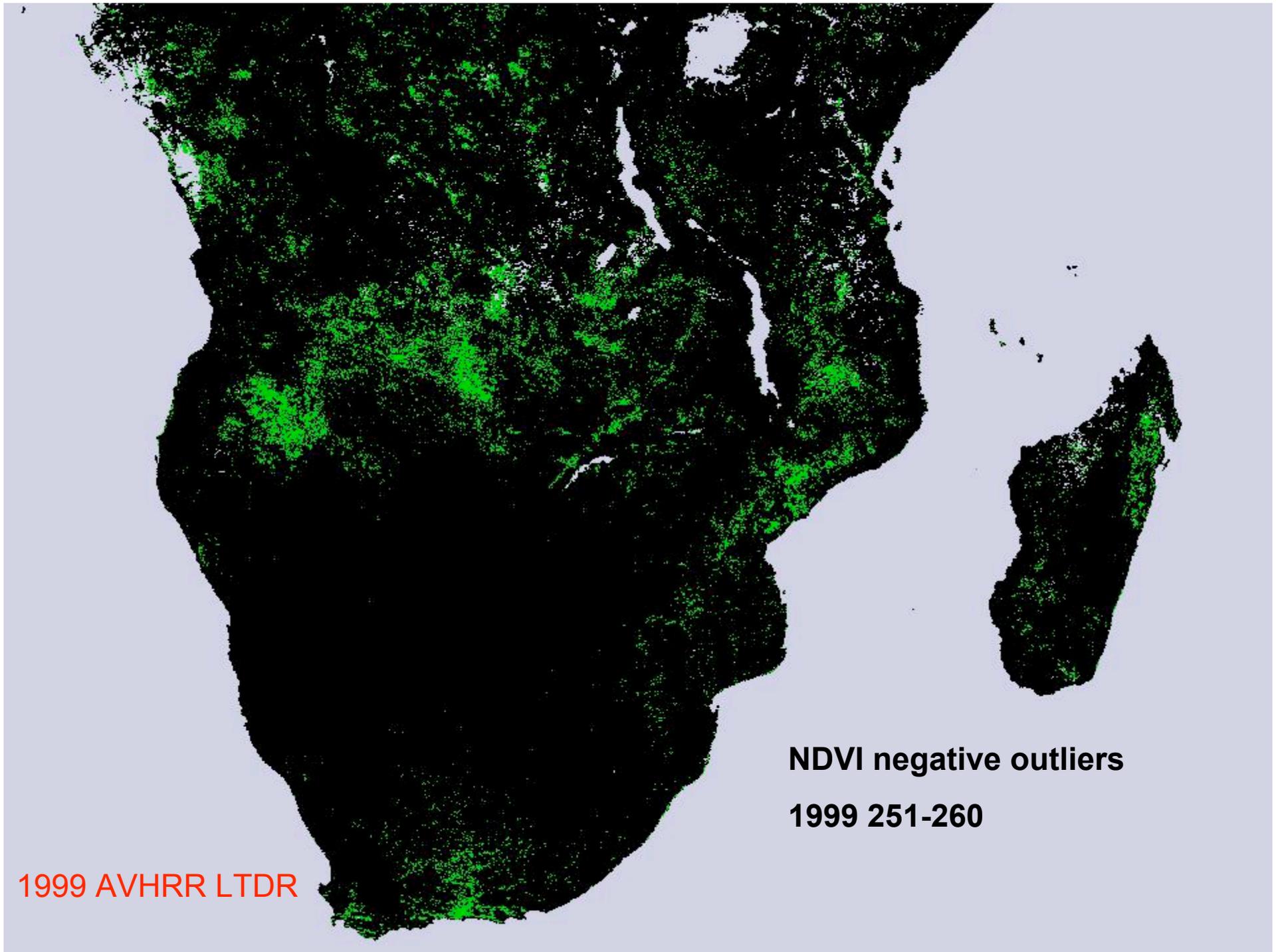
1 month



BT3 positive outliers

1999 251-260

1999 AVHRR LTDR



NDVI negative outliers

1999 251-260

1999 AVHRR LTDR

Next Steps

- Continue algorithm development
 - BRDF rolling compositing approaches
 - Surface temperature & ρ_3
 - Africa then Global
- Waiting for
 - aerosol correction
 - land surface temperature product
 - multi-annual data set
- Produce monthly and 10 day area burned estimates at 0.05 degree resolution
- Product comparison with other burned area products
 - 2000+ MODIS (NASA) 500m MODIS, reporting at 500m, near daily
 - 1998-2003 GLOBCARBON (ESA) 1km SPOT & ATSR, reporting at 10km, monthly
 - 1982-1999 GBS (JRC) AVHRR 8km PAL, although only derived seasonal fire probability data available to public

Overall Recommendations of the Breakout Group

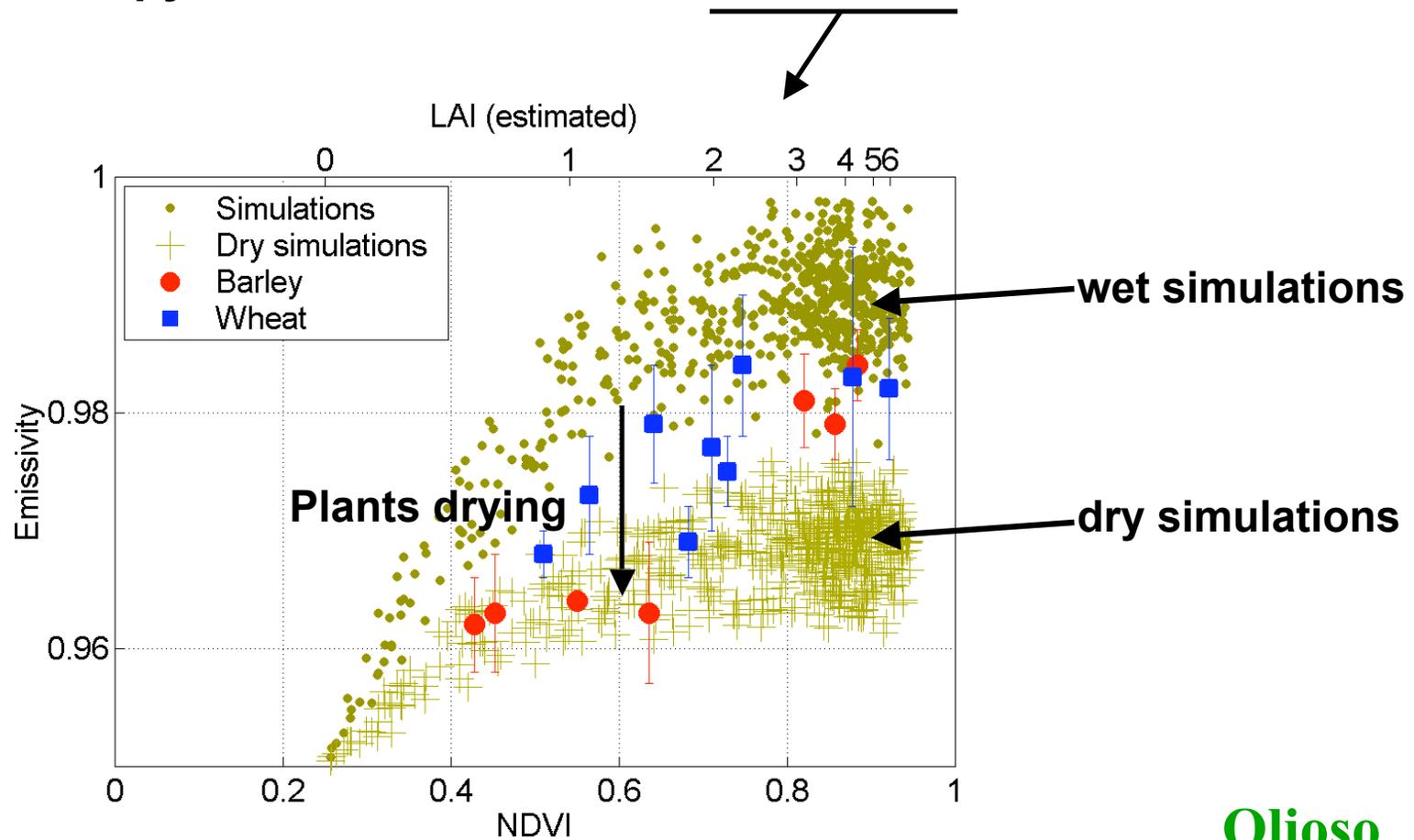
- **Top 3 priorities**
 - Validation of global products
 - Long term fire data record
 - Coordination to ensure fire obs from for future missions
- **Other important issues raised**
 - Spatial aggregation and accuracy reporting for the modeling community
 - Strengthening the land DB community
 - User requirements for burned area characterization

2-Long term burned area data record

- **Several products are now available at global scale, based on different sensors (GBA2000, Globscar, Globcarbon, MODIS Burned areas).**
- **An intercomparison exercise, on the same lines of the LAI intercomparison, is needed.**
- **A time series of almost 15 years of 1km or better resolution data exists:**
 - 1992-1997? AVHRR 1km (EDC Stitched data – Eidenshink)
 - 1996 – present ATSR, ATSR2, AATSR
 - 1998-present VGT,
 - 2000-present MODIS.
- **All of these data have been used for burned areas: the production of a single long term fire data record would require the harmonization of the algorithms and the intercalibration of the products, making use of the periods of overlap of the time series.**
- **A LTDR would require considerable effort and international will re. input data, consensus algorithm, validation data**
- **Given the effort required, the first priority should be on burned areas, rather than on active fires (because of different overpass time, intercalibration of AF can be done only at reduced resolution and with added uncertainties – diurnal cycle issues).**

Impact of leaf drying

- Spectra simulations showed that emissivity may be low for dried plants
- This is confirmed by some in-situ measurements at the canopy level in Barrax and in Marrakech



Burned Area Mapping by Combining Hotspots and Change Detection (HANDS)

1. AVHRR hotspots



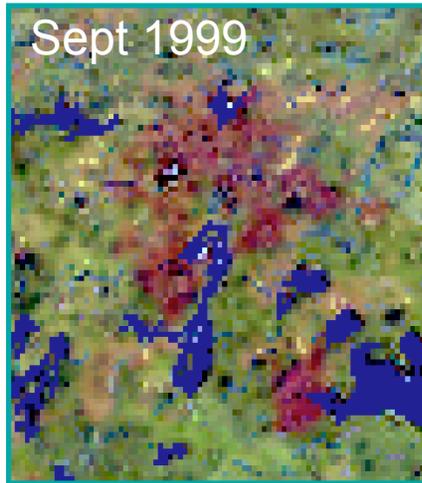
Burned Area



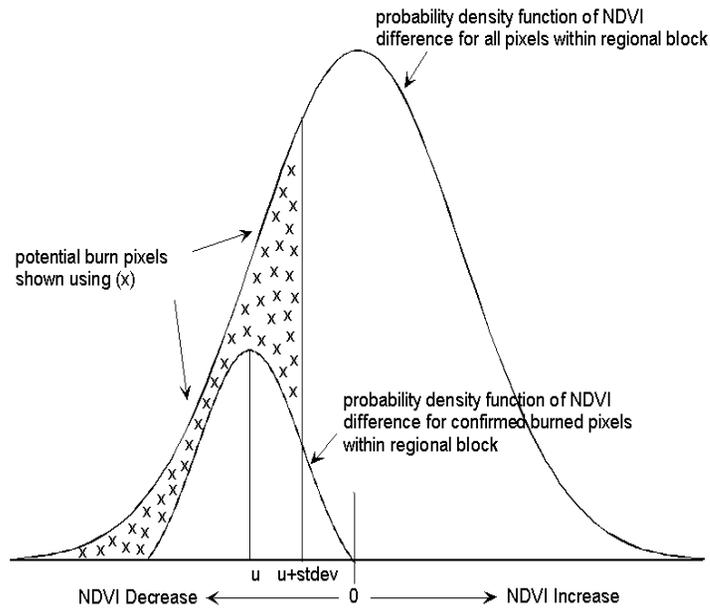
Sept 1998



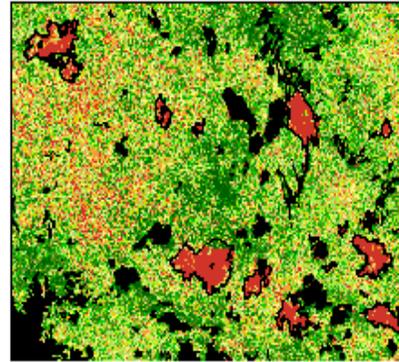
Sept 1999



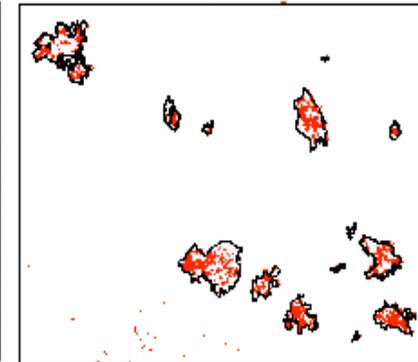
Burned area mapping by combining hotspots and change detection (HANDS)



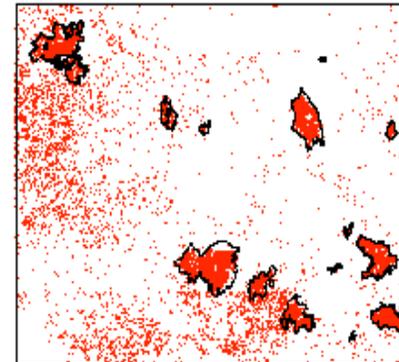
1. NDVI differencing



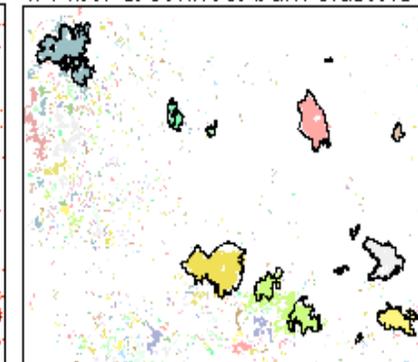
2. Confirm hotspots



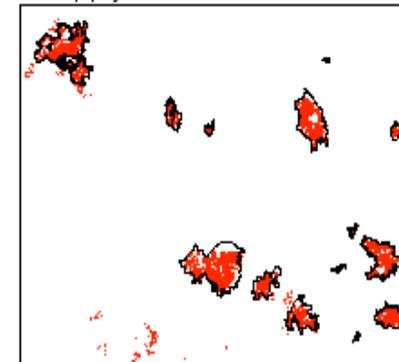
3. Apply regional threshold



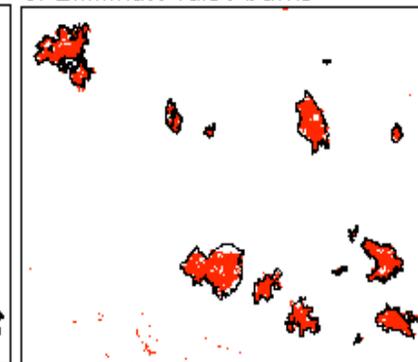
4. Filter & connect burn clusters



5. Apply local threshold

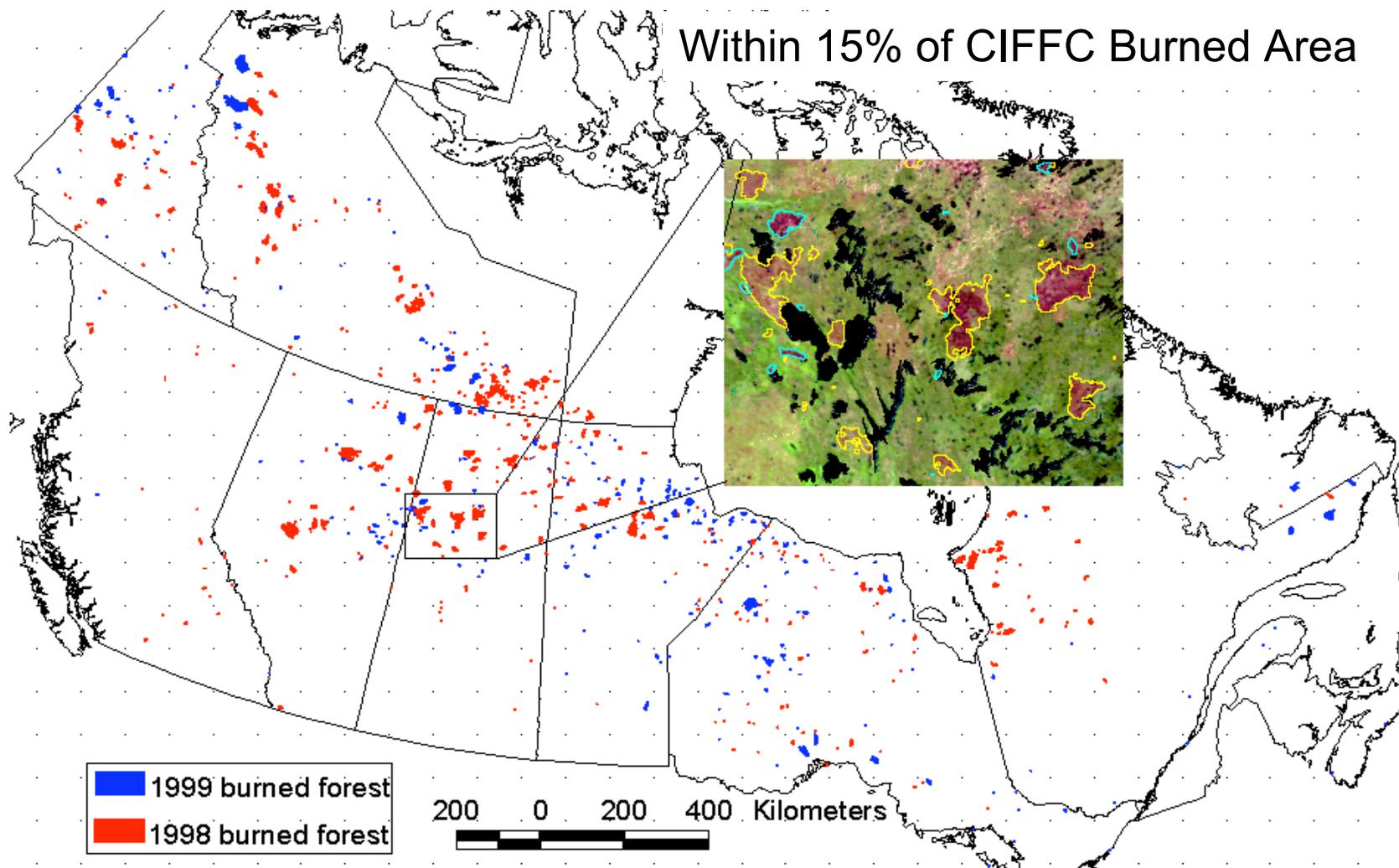


6. Eliminate false burns

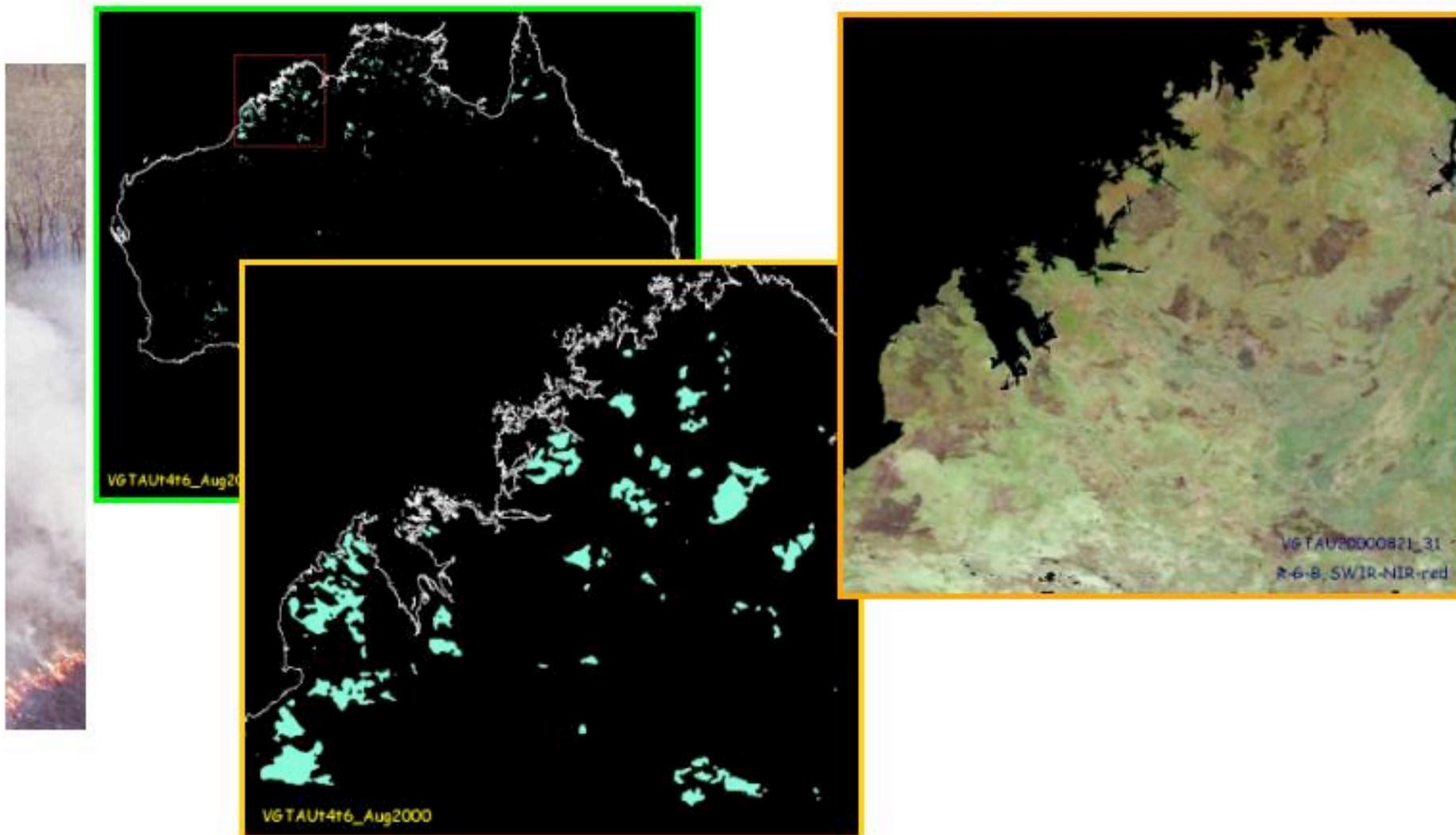


Canada-Wide Burned Area Mapping

(HANDS technique; Fraser et al.)



Burned area map of Australia (2000), SPOT 1km, produced by classification tree methodology



Example classification tree

