Impacts of acidic deposition in Tropical Africa on ecosystem function

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DEBITS II historical perspective:

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- ✓ DEBITS began in 1990 and was originally an IGAC task entitled "Composition and Acidity of Asian Precipitation" (CAAP) (Henning Rodhe and Greg Ayers)

  Changed to DEBITS in 1994 when IDAF (Africa - Jean-Pierre Lacaux) and LBA (South America - Paulo Artaxo) joined initiative with Africa and South America networks.

- ✓ The programme is driven by scientific questions related to global atmospheric chemistry

- ✓ Within this global strategy, activities should be targeted in regions of high impacts on sensitive ecosystems and human health

- ✓ The overall task should be focused on atmospheric deposition within the Earth System framework to assess responses and feedbacks within the system

DEBITS II, SA Regional Programme and ABC Africa

Scientific objectives:

- ✓ To measure the atmospheric removal rates by dry and wet deposition of biogeochemically important trace species on a long term
- ✓ To study key regulating processes (interaction gas/aerosol/cloud/ecosystem)
- ✓ To establish at regional and local scale atmospheric budgets of key elements and regional plume dynamics
- ✓ To relate the deposition fluxes measurements to impact studies at the ecosystem level

Current measurements

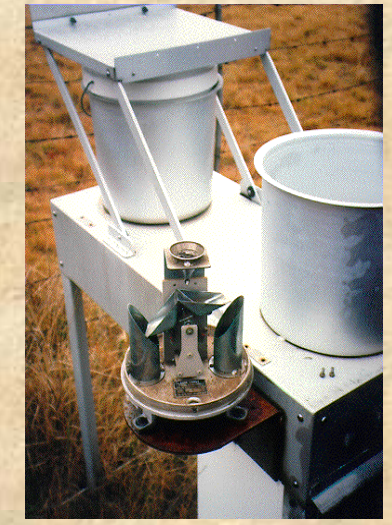
- **Gas concentrations**

Passive gas sampling (month) for SO_2, NO_2, NH_3, HNO_3 and O_3

- **Chemical composition of precipitation**

Wet-only sampling (events), preservation by a biocide or by freezing
US EPA quality criteria + annual analytical laboratory performance (WMO)

pH, Conductivity, Inorganic and Organic major ions
(Cl^- , NO_3^- , SO_4^{2-}, HCO_3^- , CO_3^{2-}, Na^+ , NH_4^+, K^+, Mg^{2+} , Ca^{2+}, HCOOH, CH_3COOH, C_2H_5COOH)



- **Chemical composition of aerosols**

Monthly sampling – PM2.5 and PM10

Inorganic and organic major ions
(Cl^-, NO_3^-, SO_4^{2-}, HCO_3^-, CO_3^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, HCOOH, CH_3COOH, C_2H_5COOH)

Particulate carbon (TC, OC and BC)

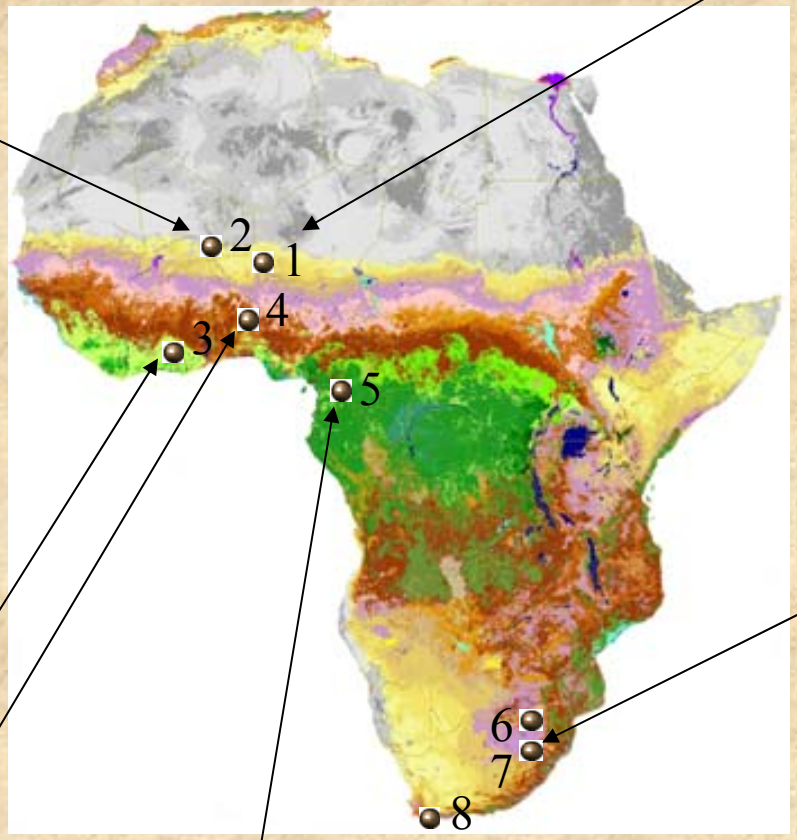
IDAF Sites Precipitation chemistry

Katibougou (Mali)

Active since 1995..

Hombori Mali

Active since 2004…



Banizoumbou (Niger)

(Galy and Modi, 1998,

Laouali et al, 2007)

Active since 1994…

Lamto (CI)

Yoboué et al, 2006

Active since 1994..

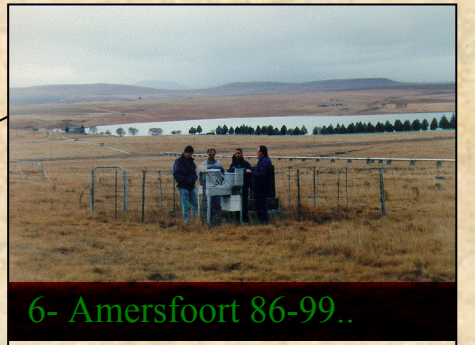
Djougou (Benin)

Active since 2005

Zoétélé (Cameroun)

Sigha et al, 2004

Active since 1996



6- Amersfoort 86-99..

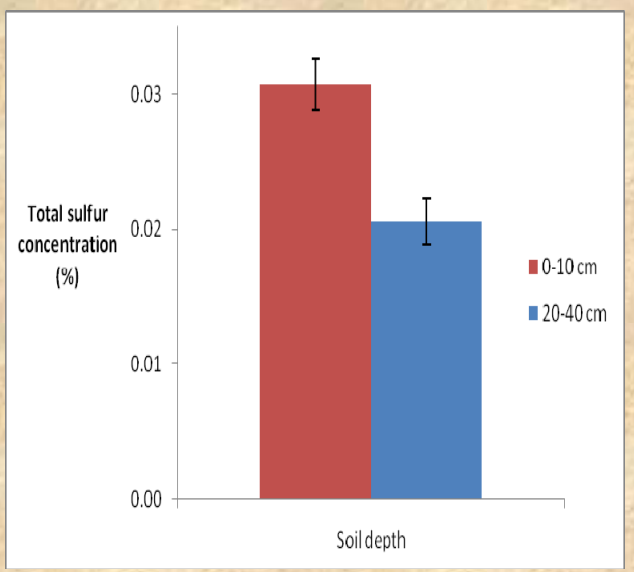
7- Louis trischardt 86-99..

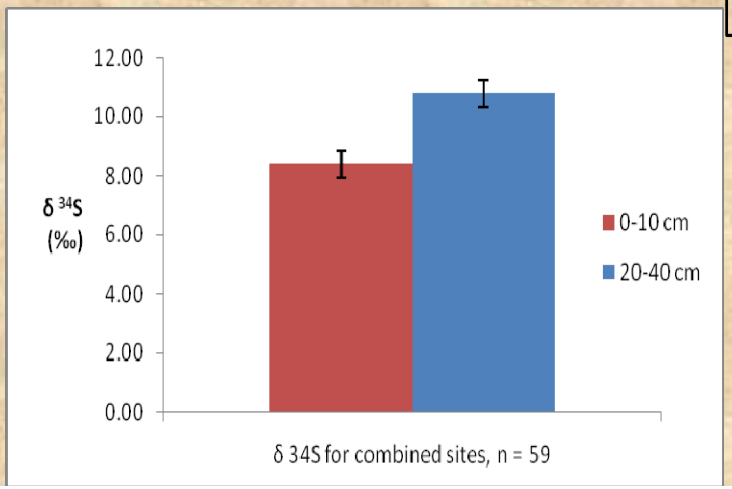
8- Cape Point 2004…

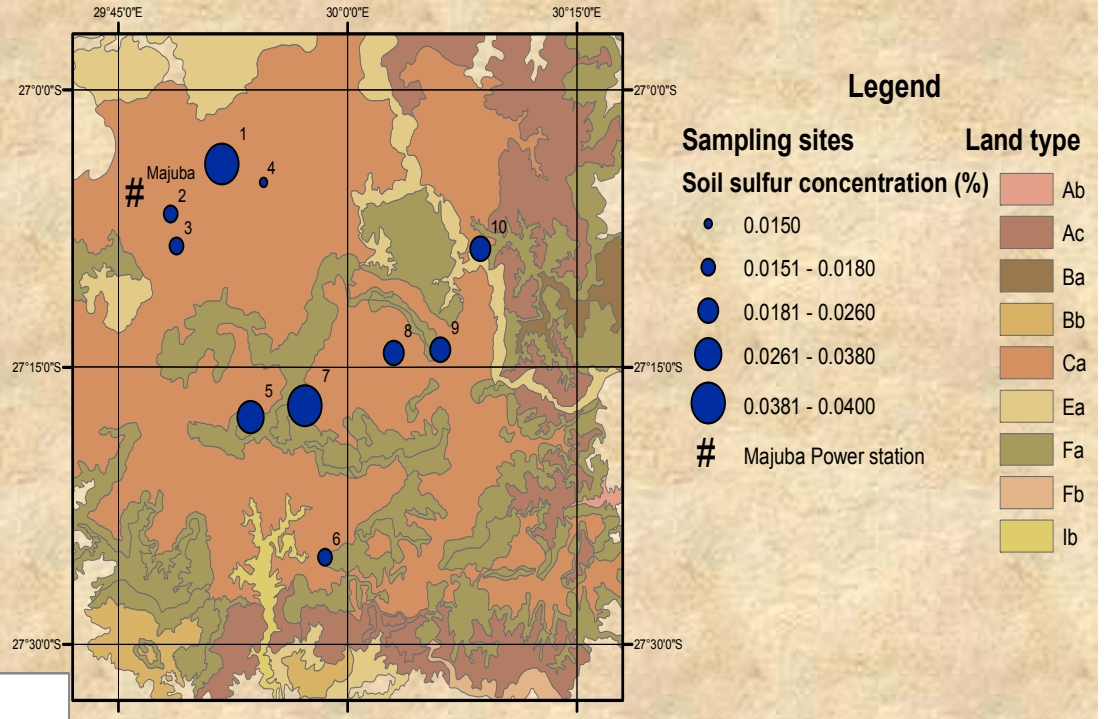
9 Skukuza 1999-

Mphepya et al, 2003, 2005

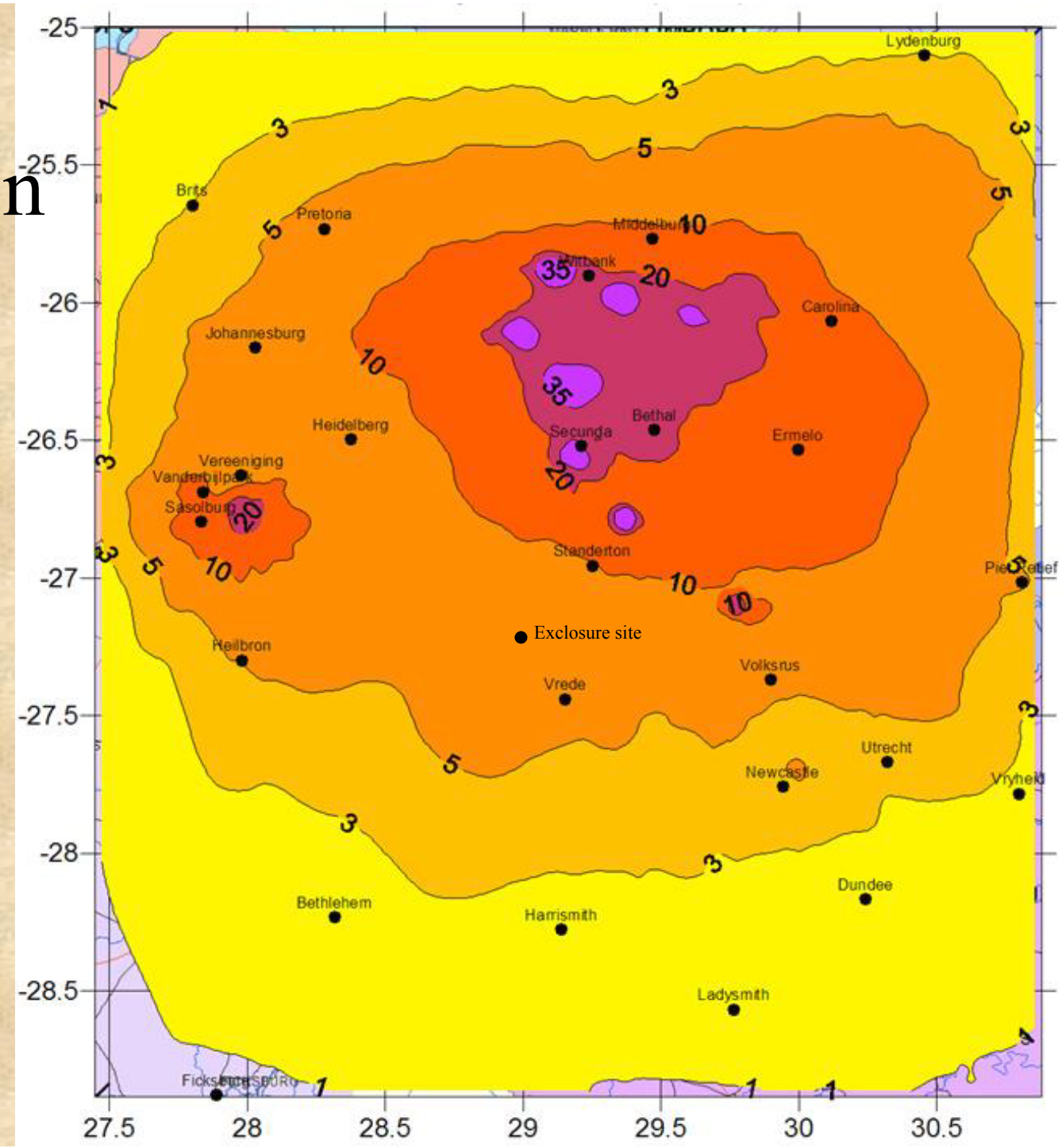
Total Sulfur and Sulfur isotopes







S deposition



Nitrogen Atmospheric deposition in Africa

Stations Ecosystems	West Central Dry savanna	West Central Humid savanna	West Central Forest	South Africa Dry savanna	South Africa Industrial Site
N-wet (NO_3^- +NH_4^+)	2.8	4.4	4.7	3.7	9.5
N-particles (p-NO_3^-+p-NH_4^+)	0.12	0.08	0.06		
N-gas (HNO_3+NO_2+ NH_3)	5.3	12.5	14.2	5.3	5.6
Total N DEPOSITION KgN ha^{-1} yr^{-1}	8	17	19	9	15

Wet Nitrogen Deposition

9 IDAF sites: NO3- and NH4+ VWM (98-2000) and Mean annual rainfall (500-2000 mm/yr)

Nitrogenous wet deposition : 3 - 10 kg N/ha/yr (dominated by N-NH_4+ 60%)

Dry Nitrogen Deposition

Estimated from gaseous (NH_3, NO_2, HNO_3) and p-NO_3-,p-NH_4+ & dry deposition velocity

N-Particles low for all the ecosystems

N-gas : N-HNO_3 very low, N-NH_3 (3-5 kgN/ha/yr), N-NO_2 (0.8-1.5kgN/ha/yr) C. Galy-Lacaux et al., IGAC newsletter n°27, 2003

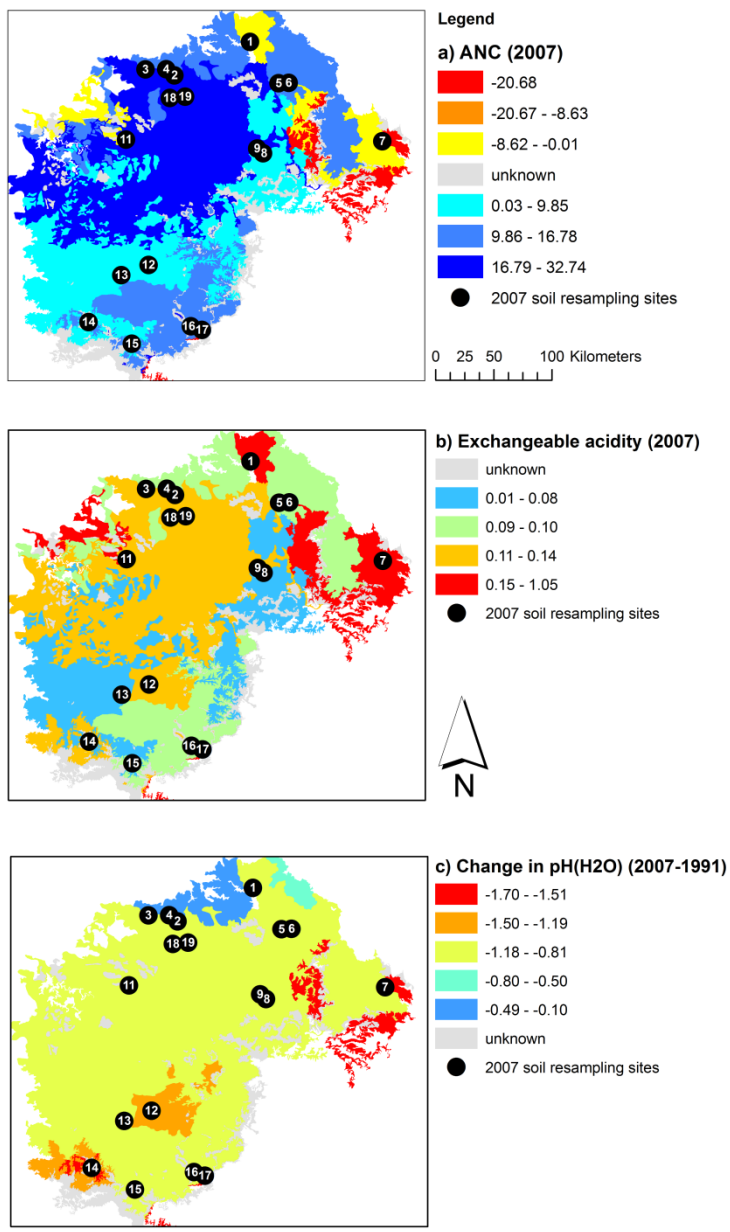


Figure 4.3: Maps showing the acidity status of the soils of the Highveld grasslands by a) acid neutralising capacity in 2007 ($cmol_c\ kg^{-1}$), b) exchangeable acidity in 2007 ($cmol_{(+)}.kg^{-1}$) and c) change in pH(H_2O) between 2007 and 1991. Sampling sites were considered representative of land type in which they occurred and where more than one site occurred on the same land type, a mean of the site values was used to represent the land type.

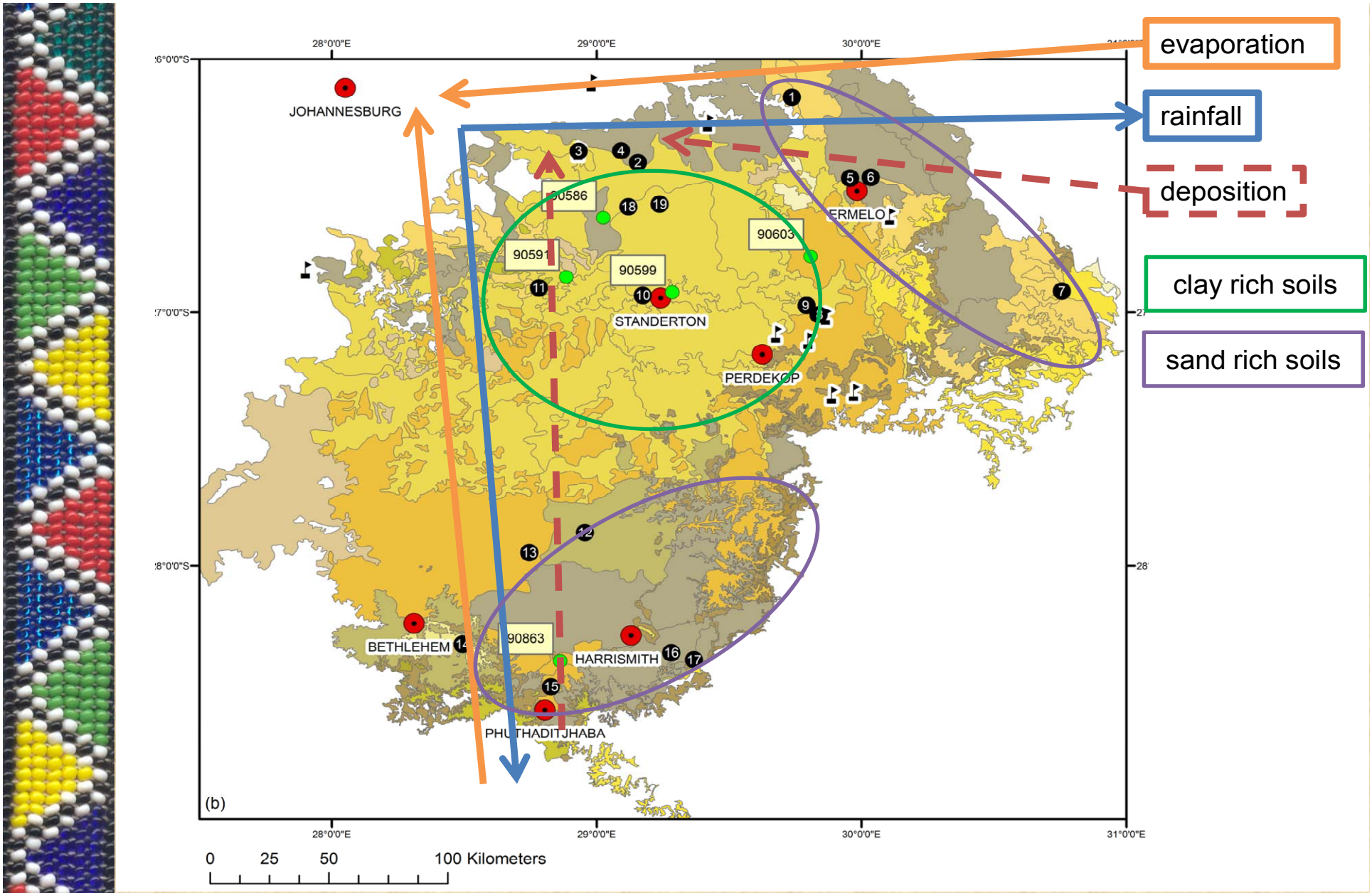
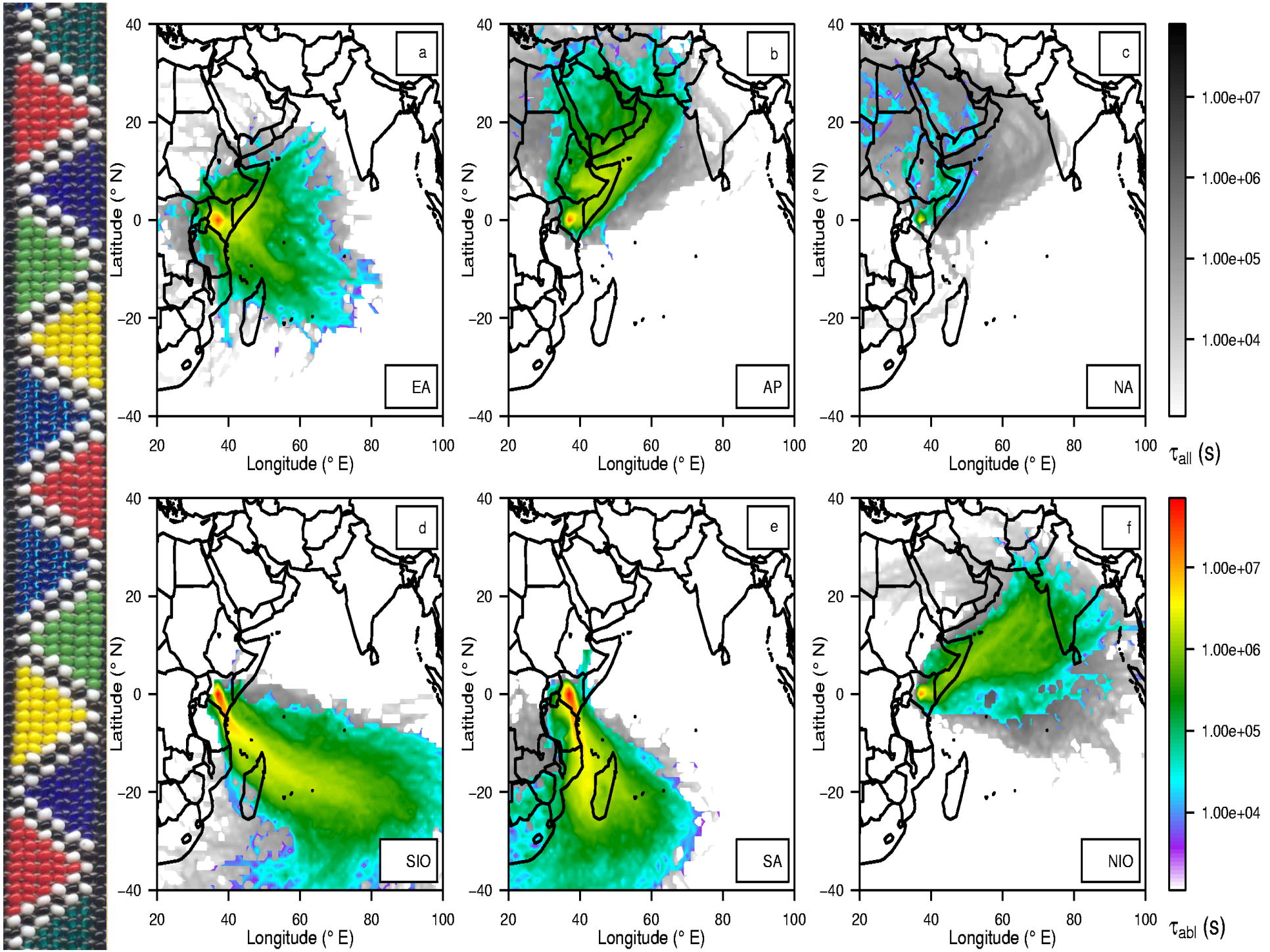


Figure 8.2: Spatial differences in evaporation, rainfall, deposition, clay rich soils and sand rich soils across the Highveld grassland study area. The direction of the arrow shows the gradient of increase: Evaporation increases northerly and westerly; Rainfall increases to the south and east; Deposition increases northerly and westerly, with a maximum in the central region of the study area.

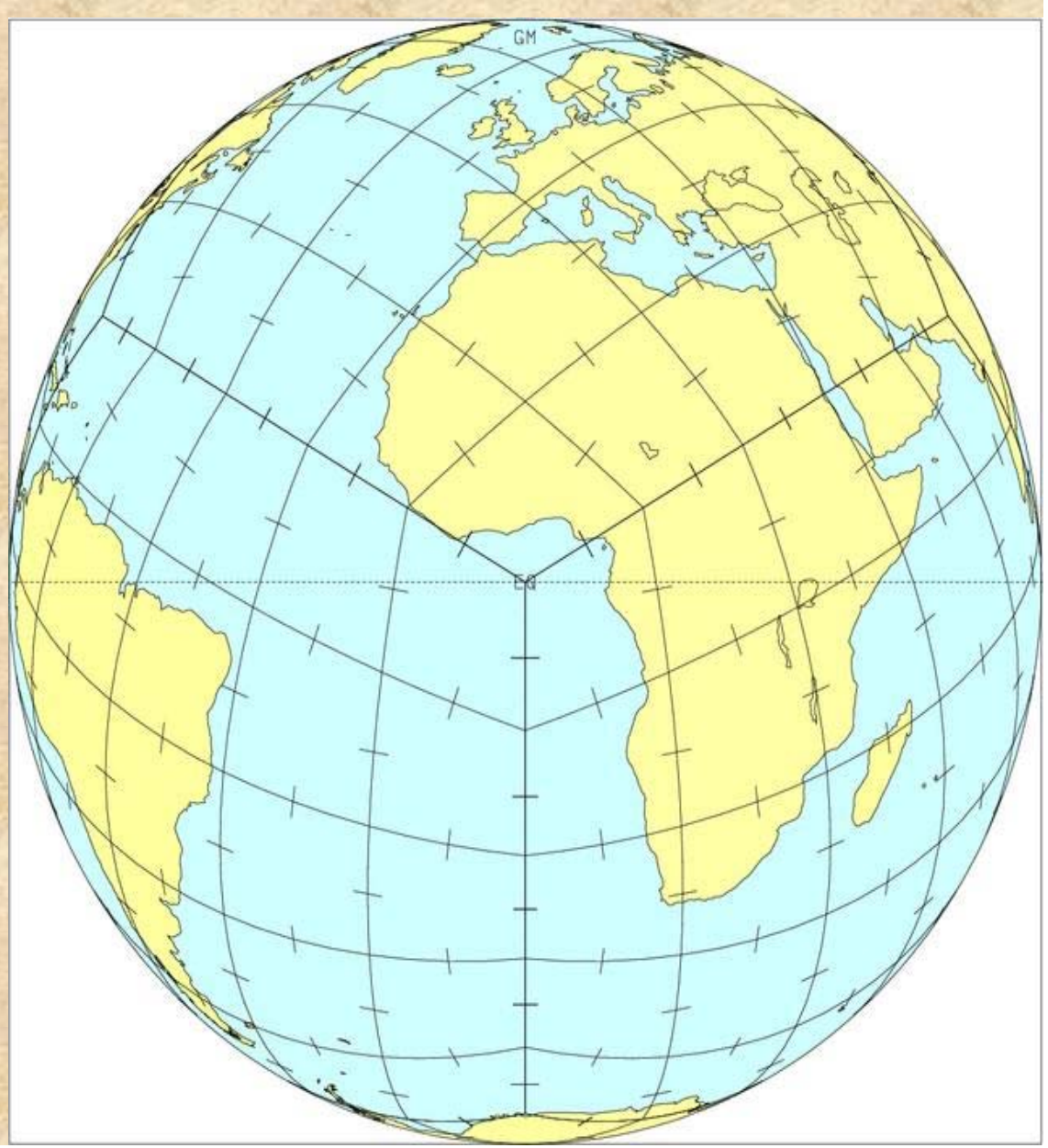

a
b
c
d
e
f
EA
AP
NA
SIO
SA
NIO
Latitude (° N)
Longitude (° E)
40
20
0
−20
−40
20
40
60
80
100
1.00e+07
1.00e+06
1.00e+05
1.00e+04
τall (s)
τabl (s)

Development of a new cube-based Earth System Model in Africa (CSIR-CSIRO-JAMSTEC collaboration)

- Based on a cube-based global atmospheric model of CSIRO and a cube-based global ocean model of JAMSTEC

Future plans:

- Simulations of Southern Hemis climate dynamics
- Simulations of the carbon cycle of the Southern Ocean and sthern African landmass
- Projections of future climate change (CMIP5/AR6)
- Paleo climate simul



SUMMARY

1. Databases being established
2. Impacts on ecosystems especially soil and water chemistry now measurable
3. Coupled models being established
4. Long-term instrumented catchments being established

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