



**The Abdus Salam  
International Centre for Theoretical Physics**



**2148-5**

**Fifth ICTP Workshop on the Theory and Use of Regional Climate  
Models**

*31 May - 11 June, 2010*

**The SOCOCA Project and role of RegCM4 in it**

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University of Oslo  
NORWAY*



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# The SoCoCA project and the role of RegCM4 in it

**Frode Stordal, University of Oslo, Department of Geosciences**

**Contributions from:**

**Bamba Sylla, Filippo Giorgi (ICTP)**

**Lena Tallaksen, Sandeep Sukumaran, Johanne H Rydsaa (University of Oslo)**

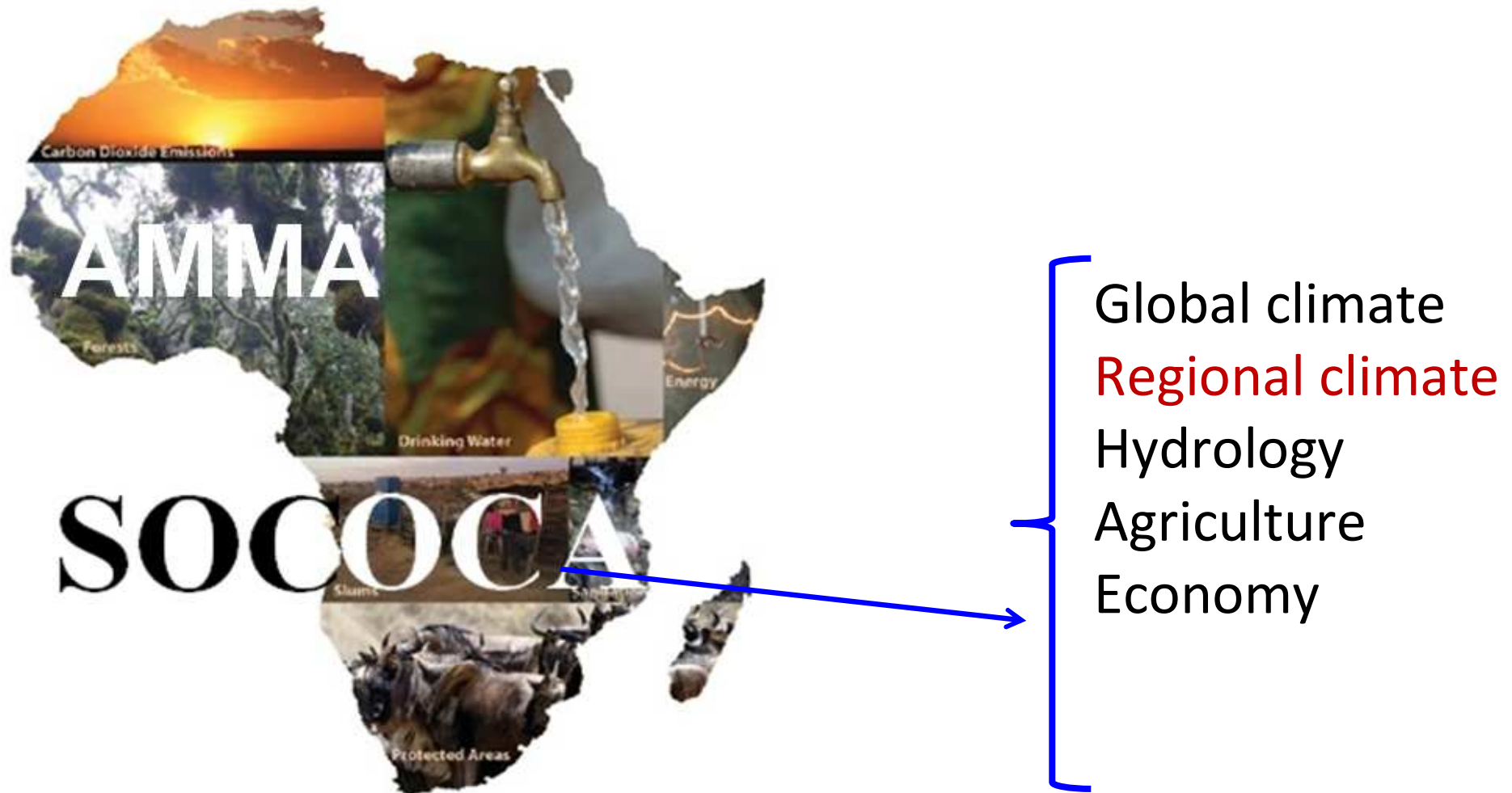


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## □ Rational for SOCOCA





# Modelling the radiative impact of aerosols from biomass burning during SAFARI-2000

Gunnar Myhre, Terje K. Berntsen, James M. Haywood, Jostein K. Sundet, Brent N. Holben, Mona Johnsrud, and Frode Stordal







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## SoCoCA's predecessor project:

### NUFU

Capacity building in water sciences for  
improved assessment and management of  
water resources



Coordinator (UIN): Lena M. Tallaksen

Coordinator (UIS): John Saka

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# NUFU Project Network Team

University	Contact Person	Other Team Members
Malawi	Jon Saka	T. Chirwa, Mathematical Sciences Department M. Monjerezi, Chemistry Department S. Sajidu, Chemistry Department C. Ngongondo, Geog. & Earth Sci. Department T. Kanyerere, Geog. & Earth Sciences Department B. Manda, Geog. & Earth Sciences Department
Oslo	Lena M. Tallaksen	Per Aagaard, Department of Geosciences Chong-yu Xu, Department of Geosciences Rolf D. Vogt, Department of Chemistry
Western Cape	Yongxin Xu Department of Earth Sciences	
Botswana	Berhanu Alemaw	Department of Geology



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# NUFU Project Objectives

- **Innovative research** – to enhance basic research in water resources (surface and groundwater) under present and a changing environment (e.g. land use and climate change), through pilot studies and regional estimation;
- **Capacity and institutional building** – to strengthen the competence and exchange of knowledge amongst the institutions involved, and subsequently contribute to the development of MSc and PhD programs in the southern Africa member countries.



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## NUFU Regional study courses - 2008

**26 May – 2 June 2008**

**Chancellor College, Zomba, Malawi**

*Water quality*

15 participants

Rolf D. Vogt, John Saka, Per Aagaard



**9 – 13 June 2008**

**University of Botswana**

*Hydrological modelling*

12 participants

Berhanu Alemaw & Chongyu Xu



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## Field campaign, Malawi June 2009



Joint effort between UiO and UNIMA. The region of study is the floodplains of the Lower Shire River in Malawi.

The main objective of the field campaign is to allow the main processes involved in **soil salinization** to be determined through data analysis and hydrological modelling.

Data collected include **soil and soilwater samples** for chemical analysis and the use of **georadar** for extensive mapping of groundwater levels.



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## SoCoCA partners

- **University of Oslo, Department of Geosciences**
- **CICERO Climate Research Centre Oslo**
- **University of Life Sciences, Noragric, Oslo**
- **ICTP Trieste, Italy**



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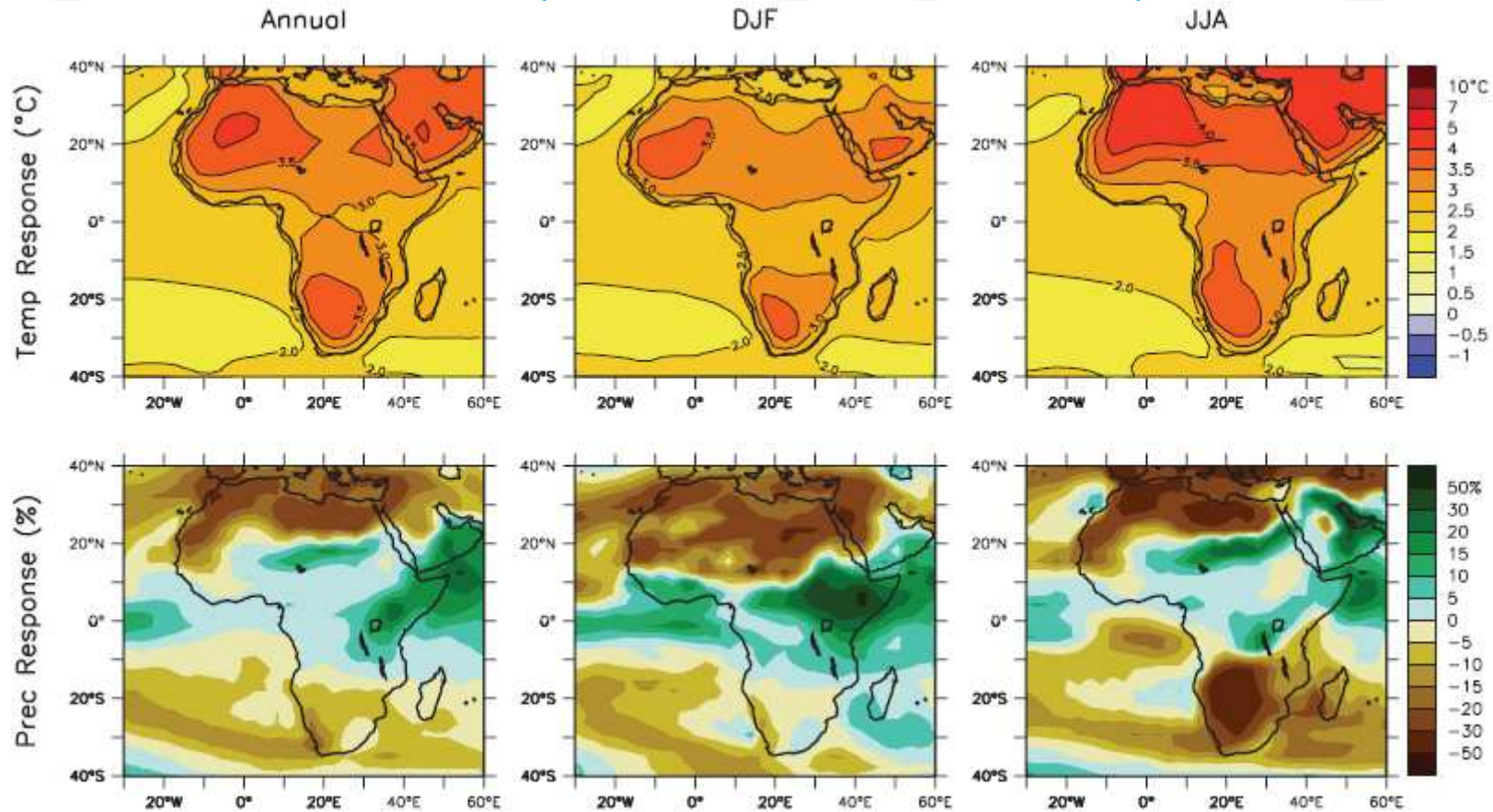
## SoCoCA framework

- **Funded by FRIMUF**
  - Environment and development
  - Interdisciplinary (natural and social sciences)
- **April 2009 + 4 years**
- **Regional climate change**
  - Main focus on **South Africa, Botswana and Malawi**
- **Building on ongoing projects and activities**
  - Project on hydrological changes in the region (NUFU)
  - ICTP projects and contacts in Africa
  - Noragric activities in Africa
  - And strong experience in a broad range of relevant themes



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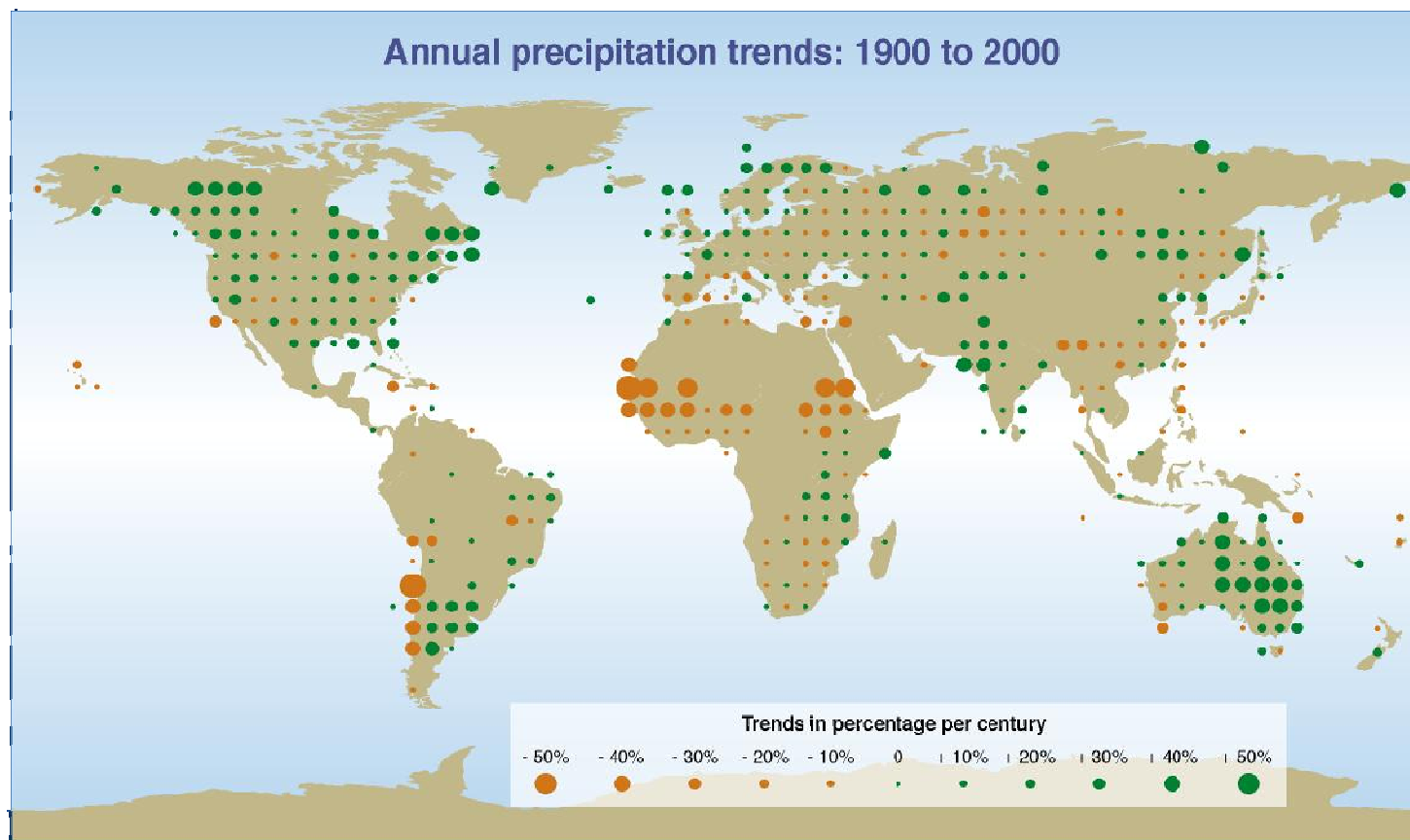


*Climate scenario predictions for Africa for the SRES A1B emission scenario from IPCC AR4. Area averaged temperature and precipitation changes are presented from the coordinated set of global climate model simulations archived at the Program for Climate Model Diagnosis and Intercomparison (PCMDI; subsequently called the multi-model data set or MMD).*





# Climate change Observed changes - Precipitation

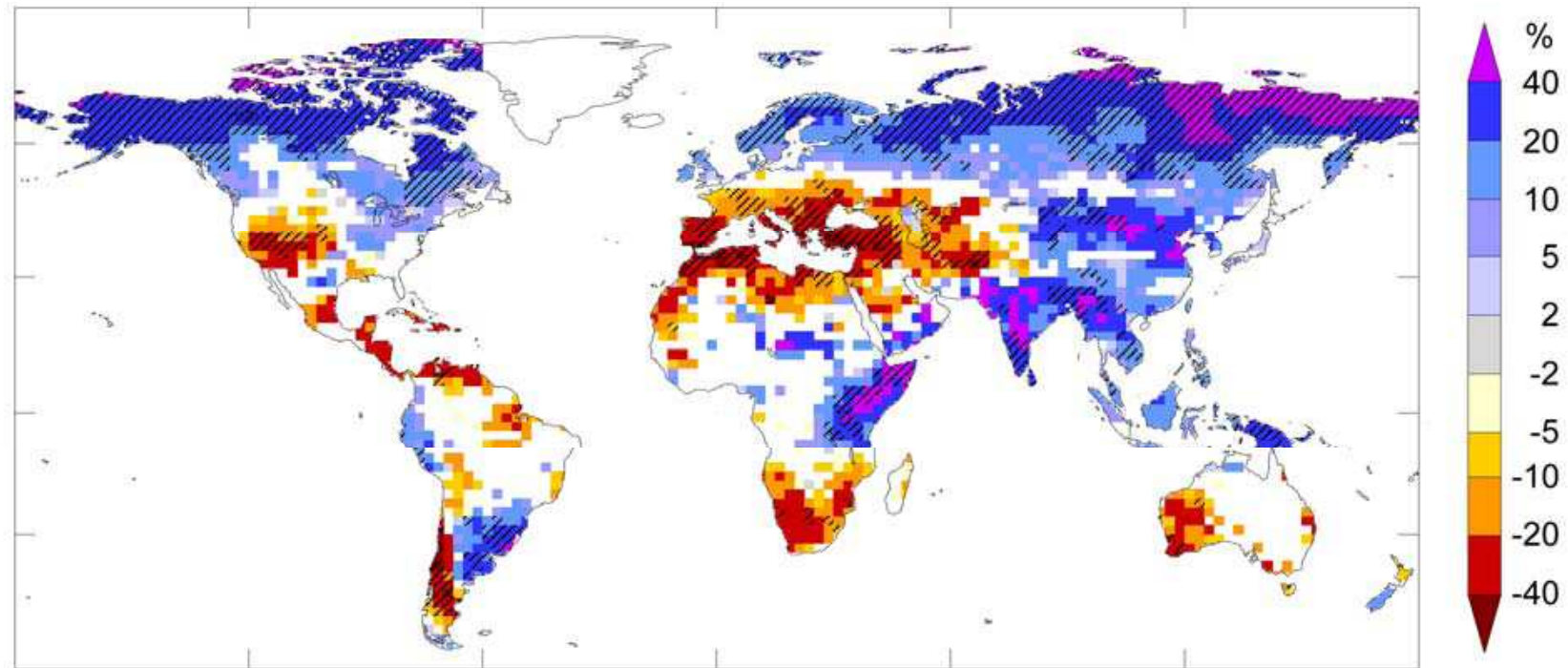




# Climate change

## Predictions – annual runoff

Large scale relative changes in **annual runoff** for the period 2090-2099, relative to 1980-1999.



from Milly *et al.*, 2005, *Nature*





# SoCoCA Workplan

WP1

Global and regional climate predictions



WP2

Regional projections of hydrological changes



WP3

Impacts on agriculture and adaptation to climate change



WP4

Socioeconomic consequences of changed water balance and agriculture





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## Models in SoCoCA

- *Global climate model: CAM Oslo (NCAR CAM3)*
- *Regional climate model: ICTP RegCM3/4*
- *Hydrological models: WASMOD*
- *Macroeconomic model: GRACE*



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## ***WP1 Global and regional climate predictions***



- *Contributions:* UiO (WP Leader: Berntsen), ICTP, collaborating institutes in Subequatorial Africa
- *Main purpose:* Produce and assess high resolution climate change projections for sub-equatorial Africa, with emphasis on changes in temperature, precipitation and the hydrologic cycle.



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## ***WP2 Regional projections of hydrological changes***

- *Contributions:* UiO (WP Leader: Xu), collaborating institutes in Subequatorial Africa
- *Main purpose:* Provide model estimates of changes in hydrological parameters needed for impacts on agriculture, such as soil moisture index, run-off, and water resources.



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## ***WP3 Impacts on agriculture and adaptation to climate change***

- *Contributions:* Noragric (WP Leader: Berg), UiO, collaborating institutes in Subequatorial Africa
- *Main purpose:* Estimate impacts on productivity in agriculture based on input from WP2, e.g. irrigation scheme, changes in land use



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## ***WP4 Socioeconomic consequences of changed water balance and agriculture***

- *Contributions:* CICERO (WP Leader. Aaheim), Noragric, collaborating institutes in Subequatorial Africa
- *Main purpose:* To estimate national economic consequences due to changes in agriculture and to exemplify how agriculture may adapt to projected hydrological changes.



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## RegCM4 in SoCoCA

- Downscaling of CAM Oslo very important
- In particular the 10 km run over Malawi

## RegCNET and ICTP in SoCoCA

- A gateway to Southern Africa in addition to the NUFU project



RecCM:

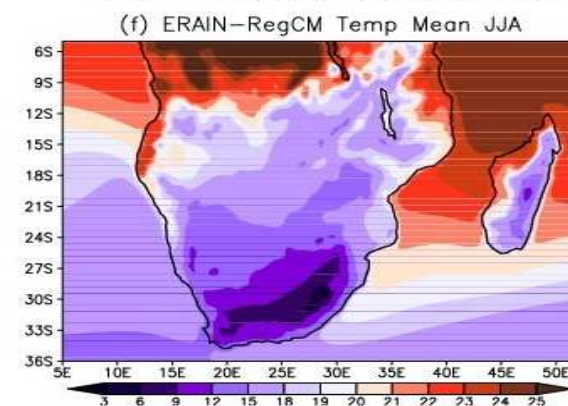
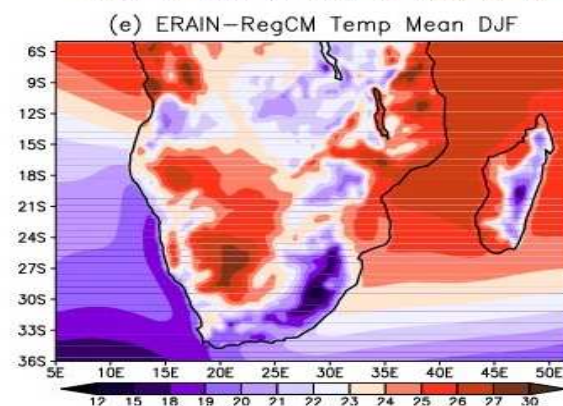
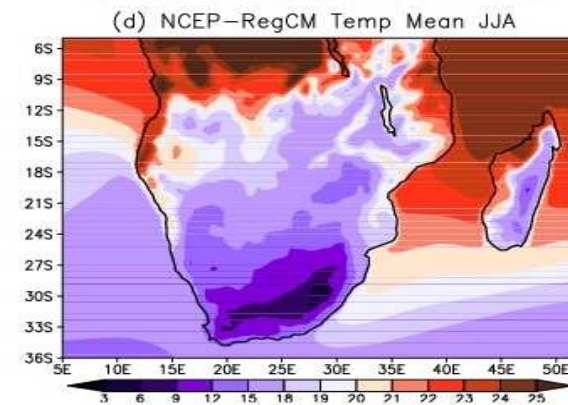
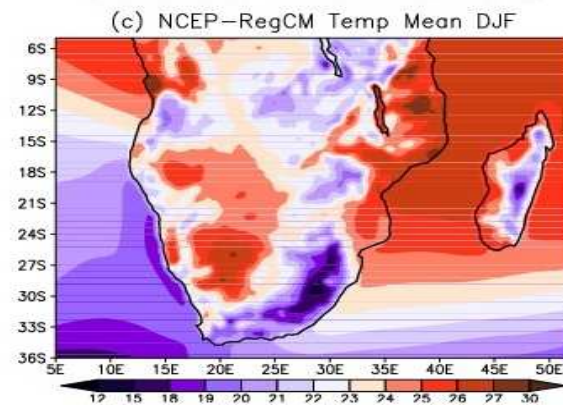
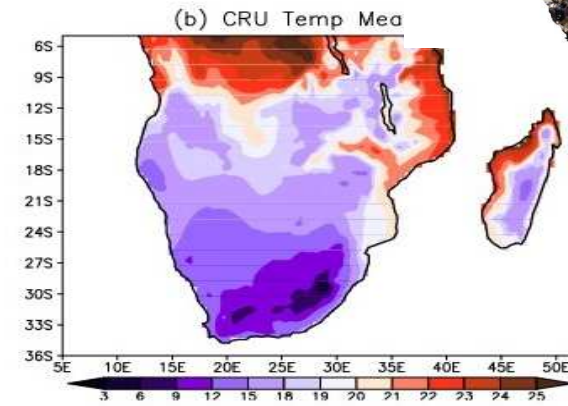
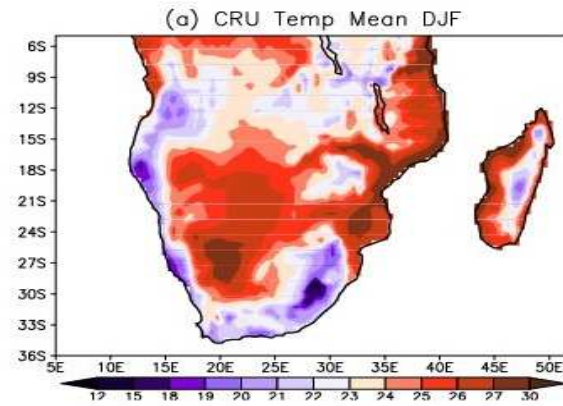
## Model description and Simulations

- RegCM3: Limited area model (Pal et al. 2007)
  - Grell convection scheme
  - Fritch and Chapel closure
  
- 2 Simulations : 10 years
  - NCEP
  - ERA-Interim

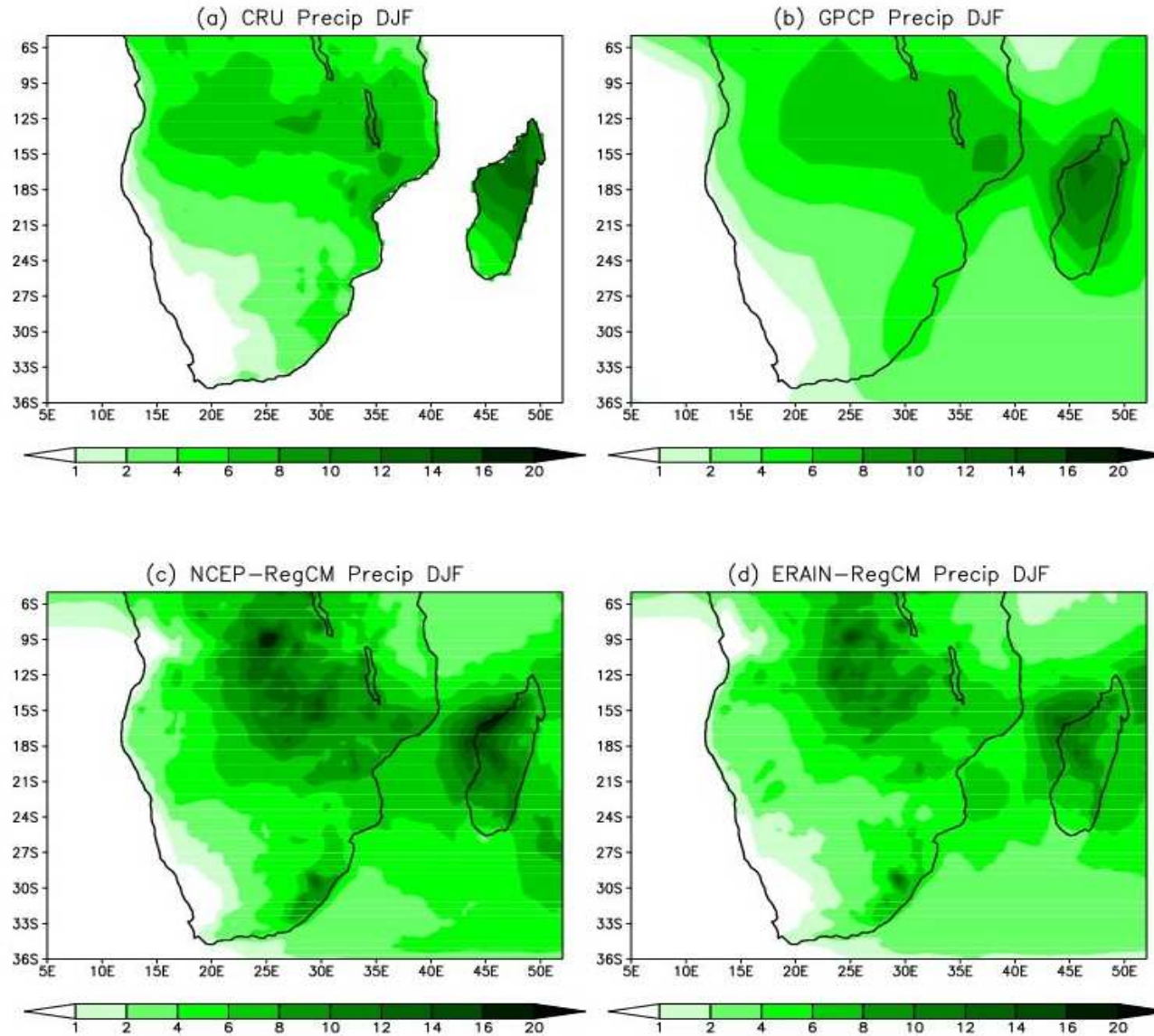




# ❖ Mean Temperature



# ❖ Precipitation





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## Macroscopical leaf lesions : stipples



bean

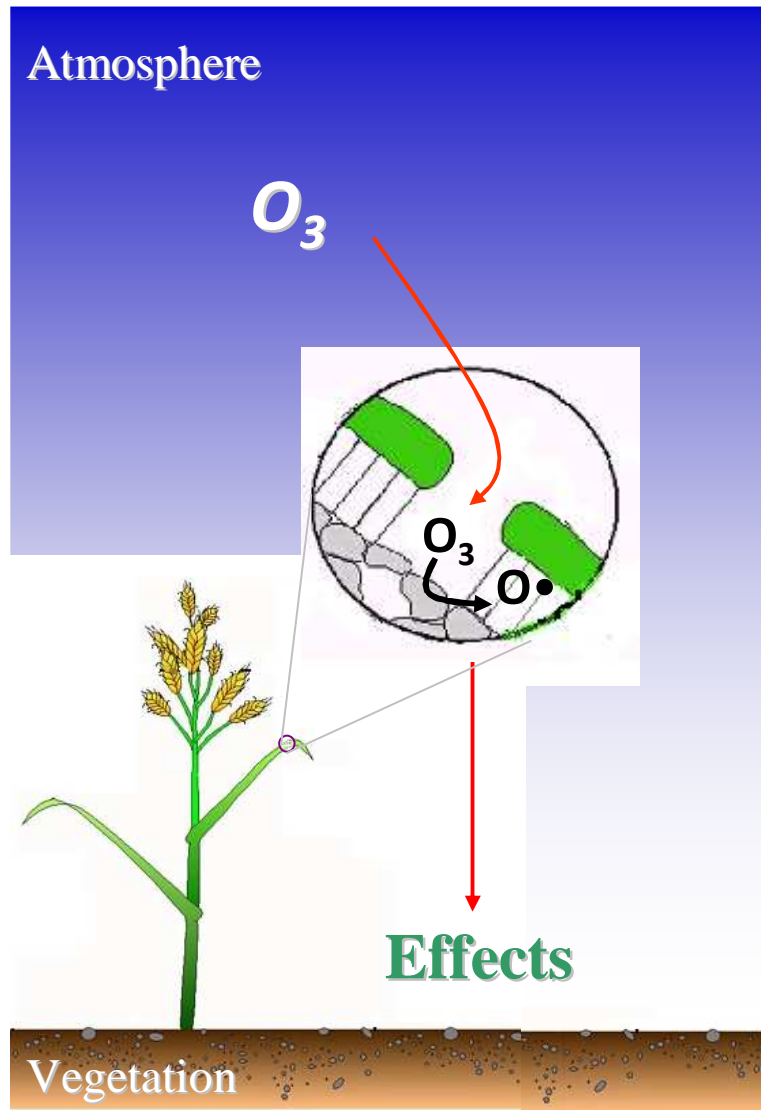


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# Ozone uptake by plants

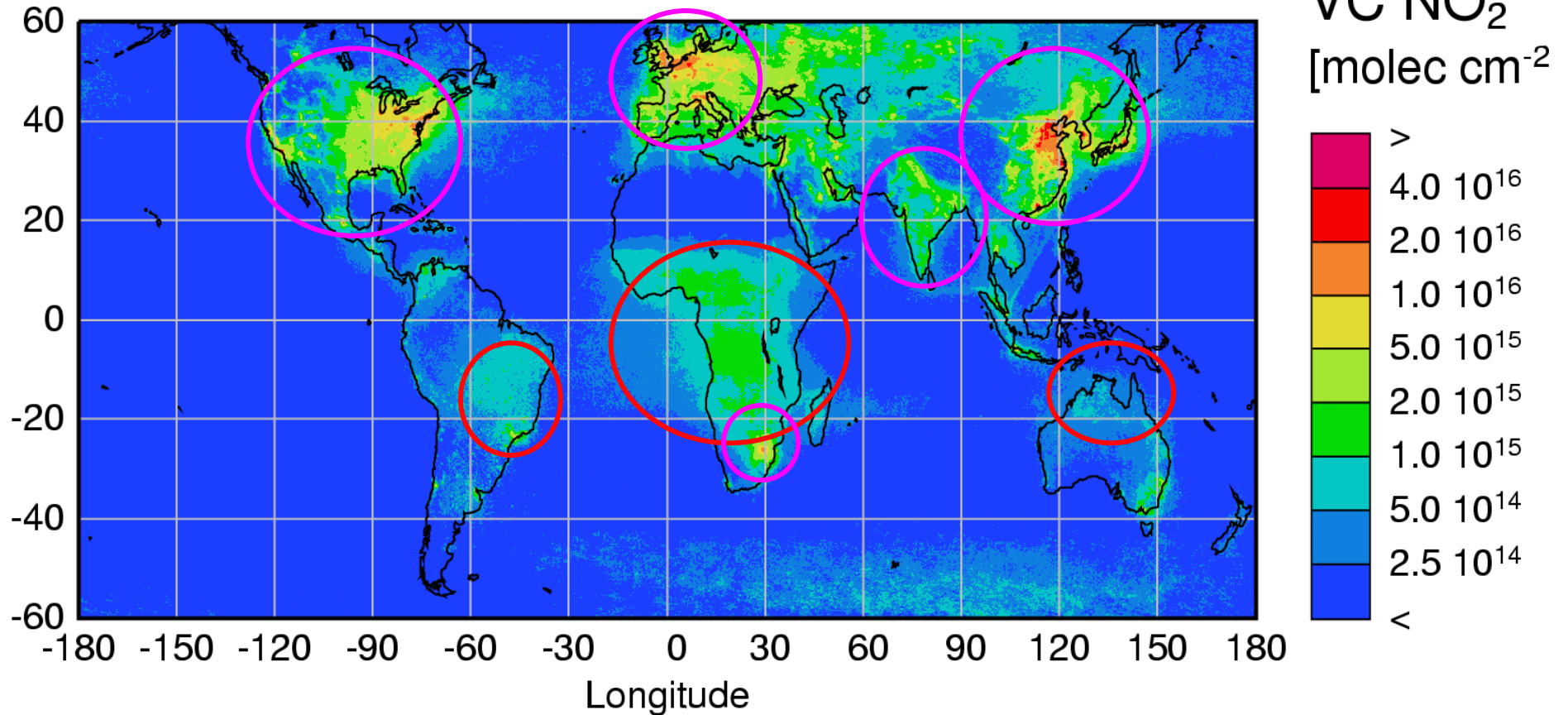


- **Only stomatal uptake**
- **No uptake through cuticle**
- **No uptake by roots**





# SCIAMACHY NO<sub>2</sub>: 08.2002 - 07.2005



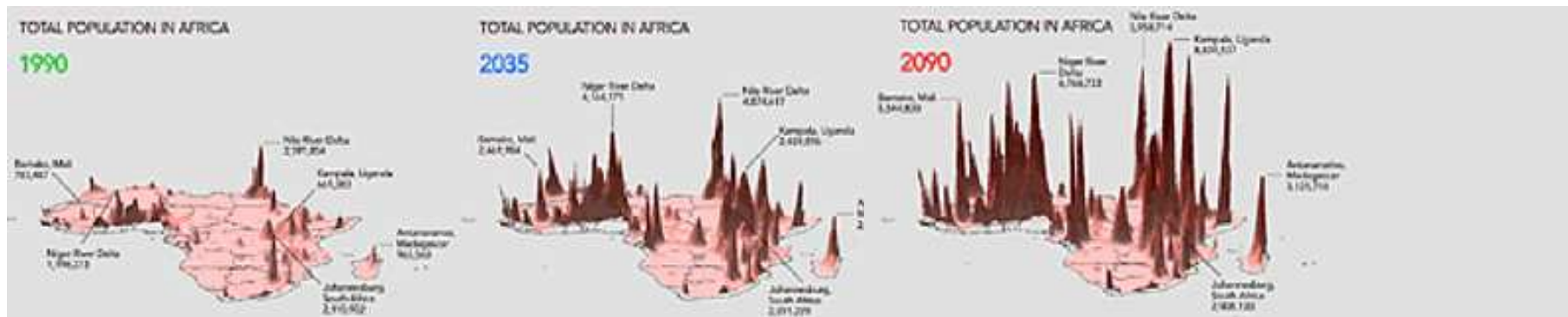
**pollution**

**biomass burning**





# Population growth in Africa



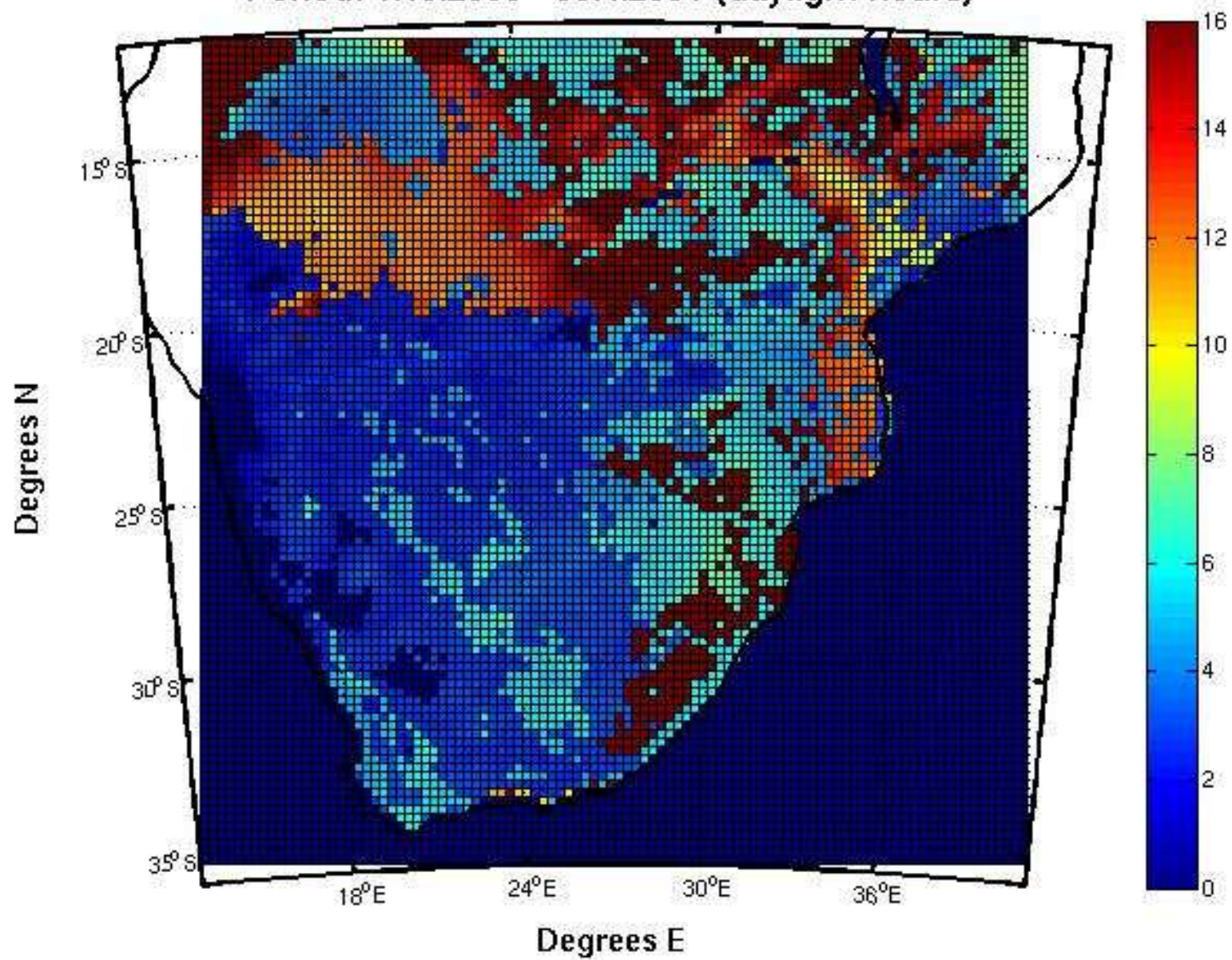
Data source: Grüber et al. (2007), IIASA  
Graphics: <http://www.populationaction.org/>





AFst0 O<sub>3</sub> (mmol m<sup>-2</sup>)

Period: 1.10.2000 - 30.4.2001 (daylight hours)



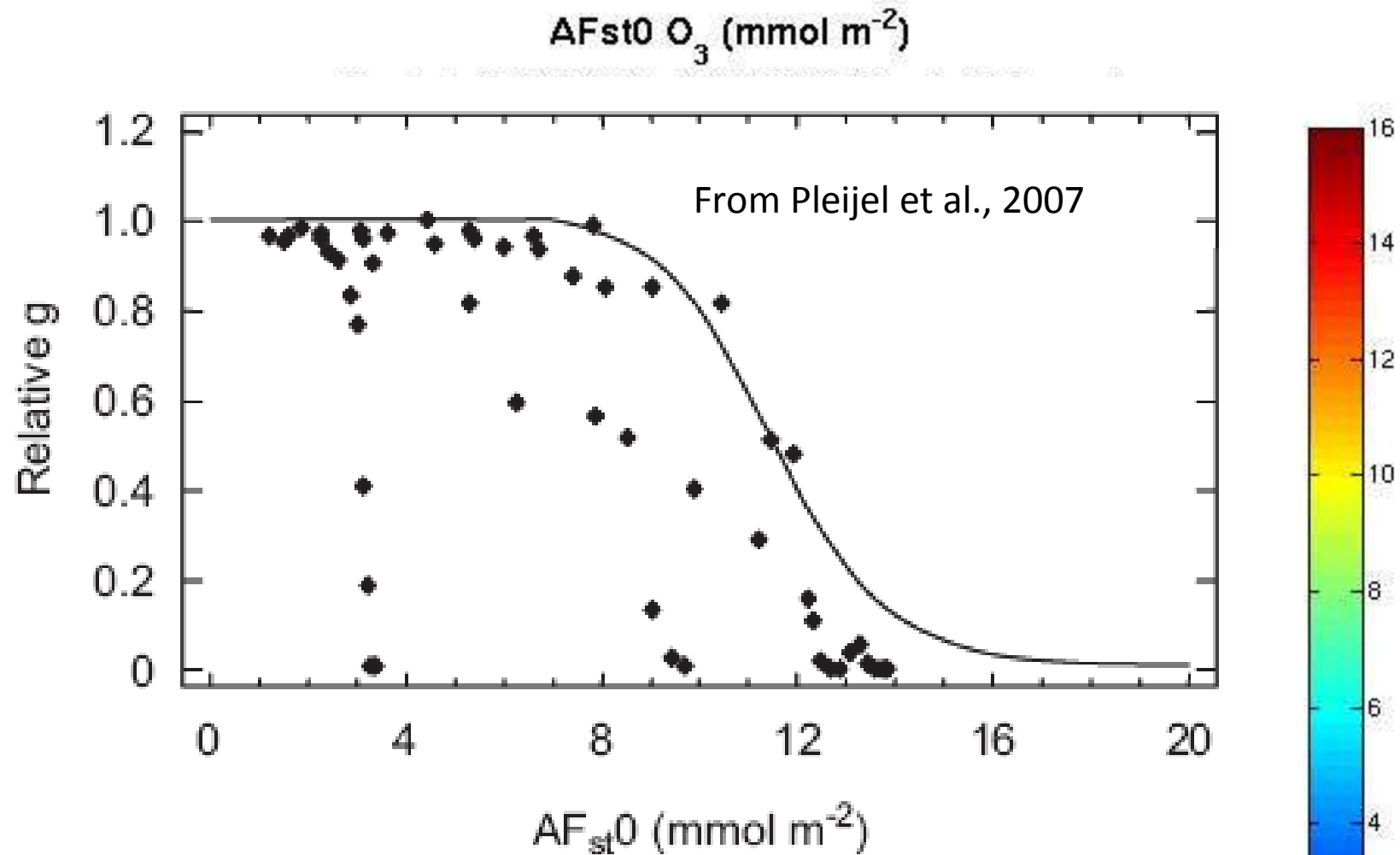
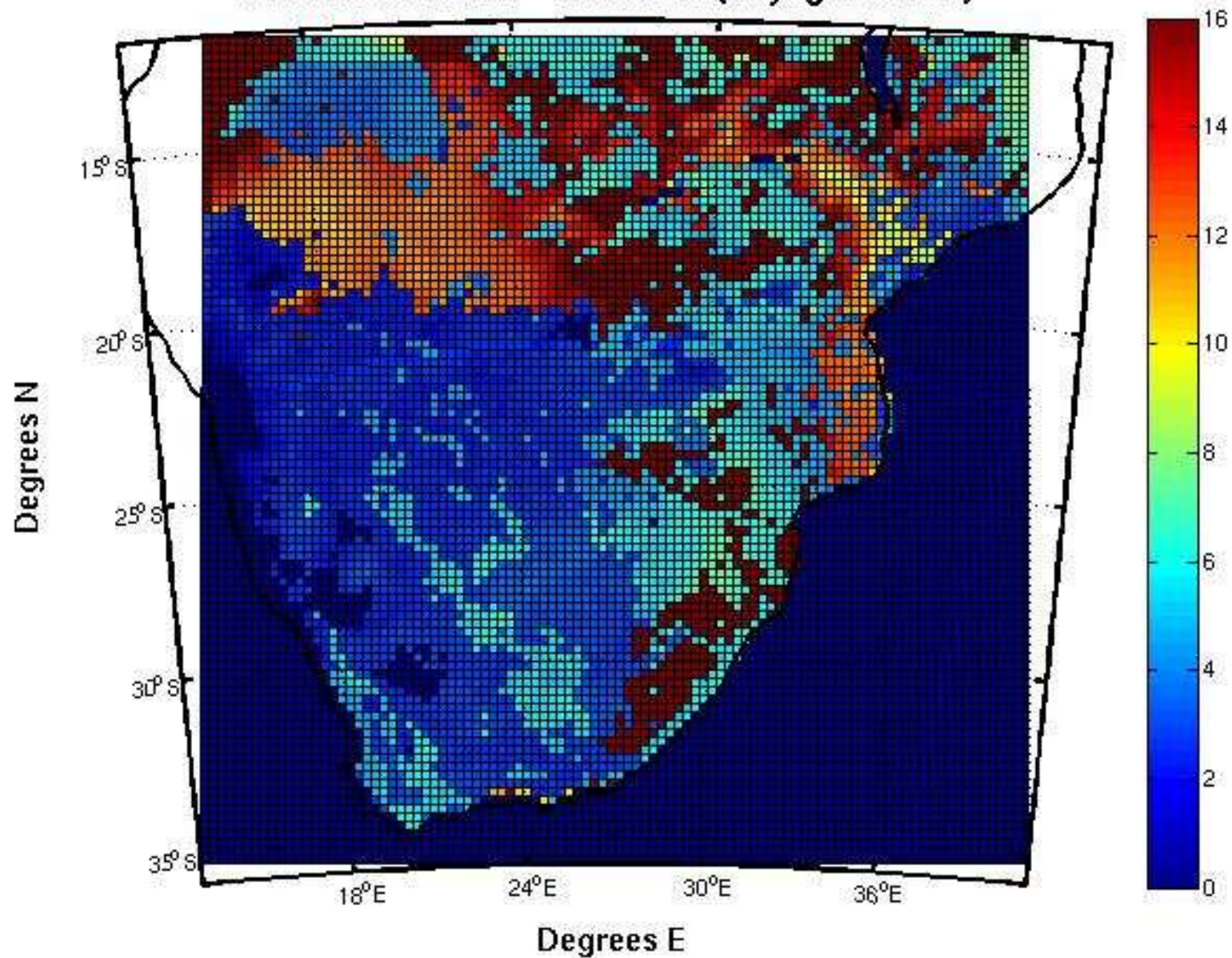


Fig. 3. The function used to describe the limitation by long-term ozone exposure, i.e. ozone induced leaf senescence, in wheat.  $AF_{st0}$  is the accumulated stomatal flux of ozone using no flux threshold.



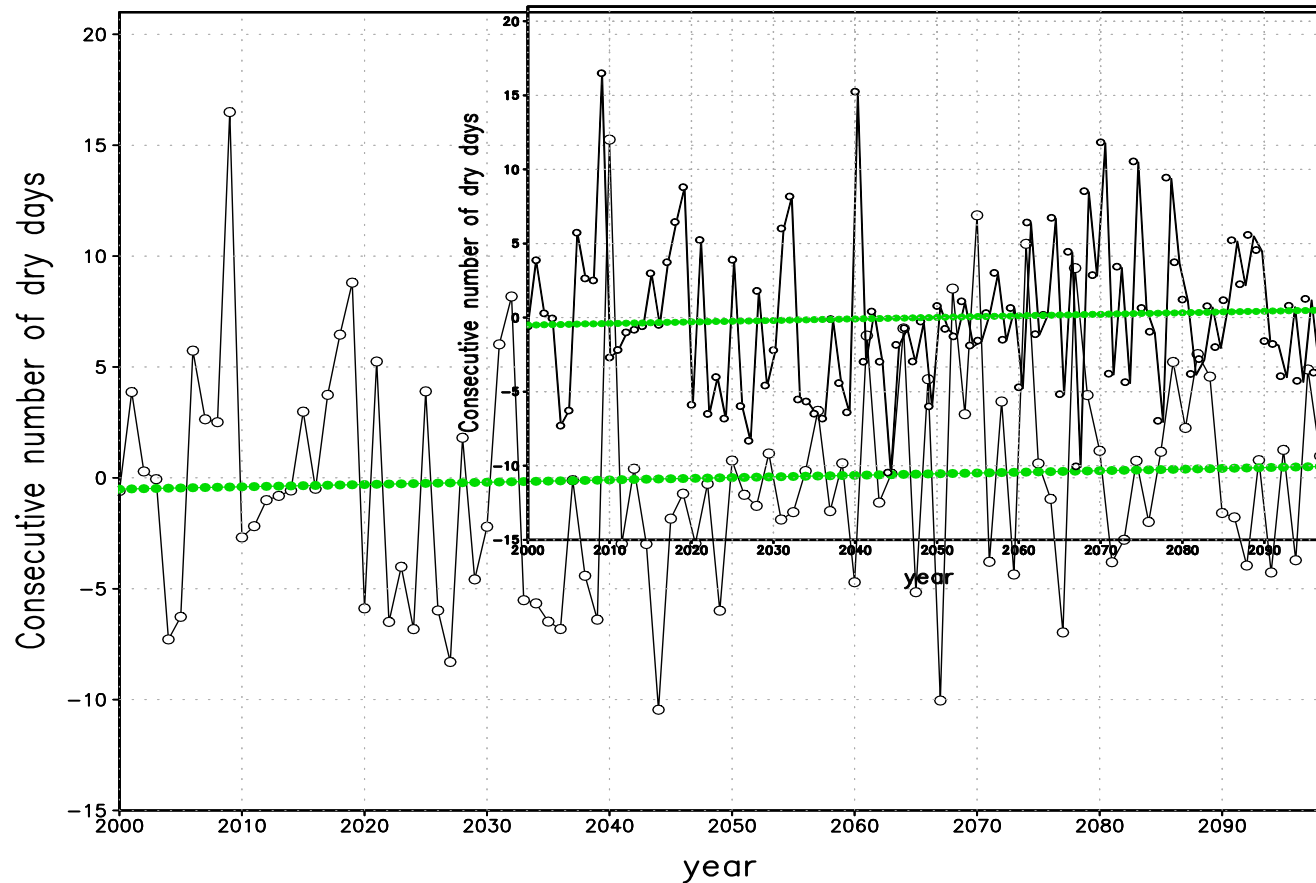
AFst0 O<sub>3</sub> (mmol m<sup>-2</sup>)

Period: 1.10.2000 - 30.4.2001 (daylight hours)





# Maximum number of consecutive dry days ( $R_{\text{day}} < 1\text{mm}$ )



**SRES-A1B CDD anomaly 20-30E, 35-25S**

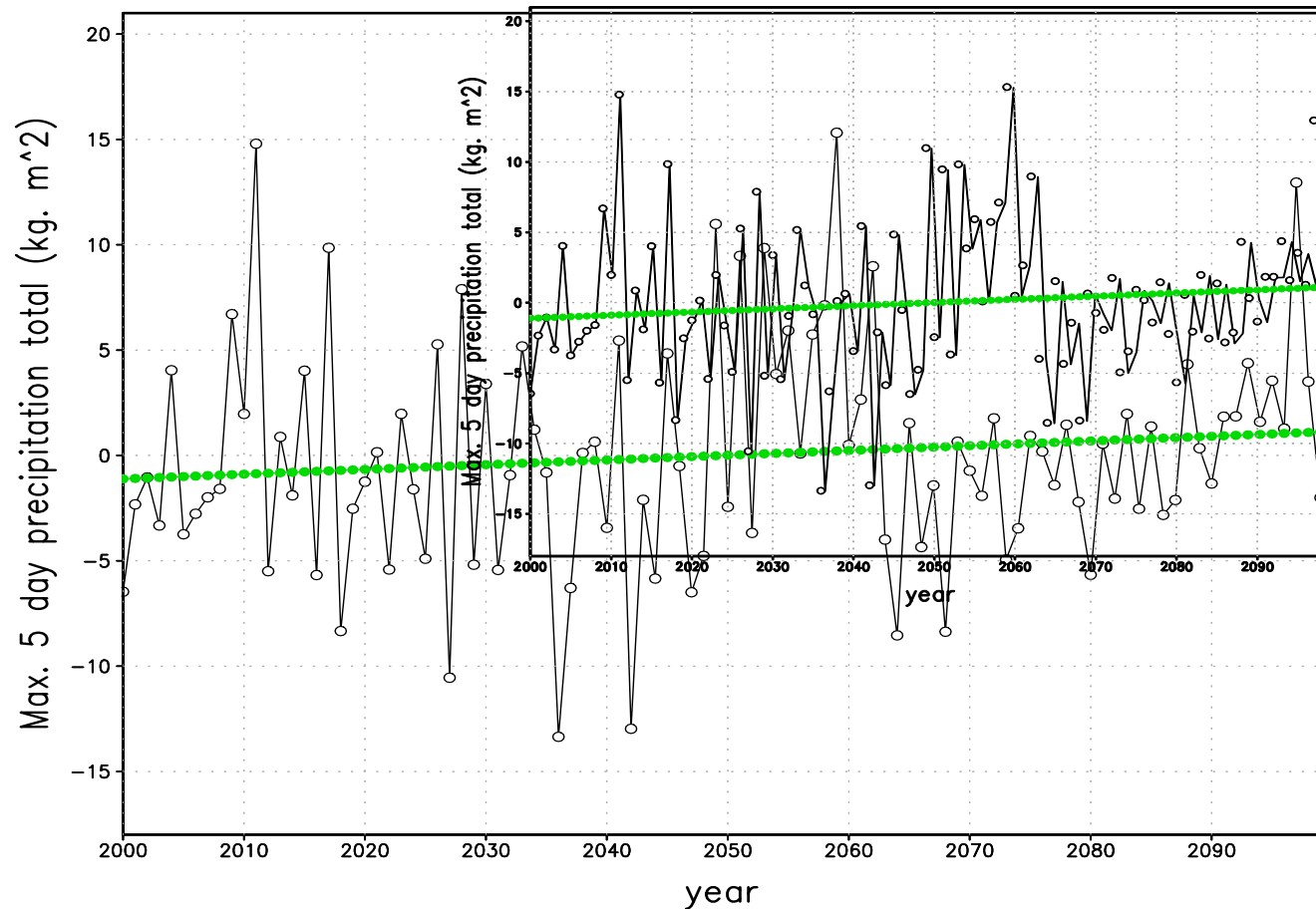




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## Maximum 5 day precipitation total Potential flood indicator



**SRES-A1B CDD anomaly 20-30E, 35-25S**



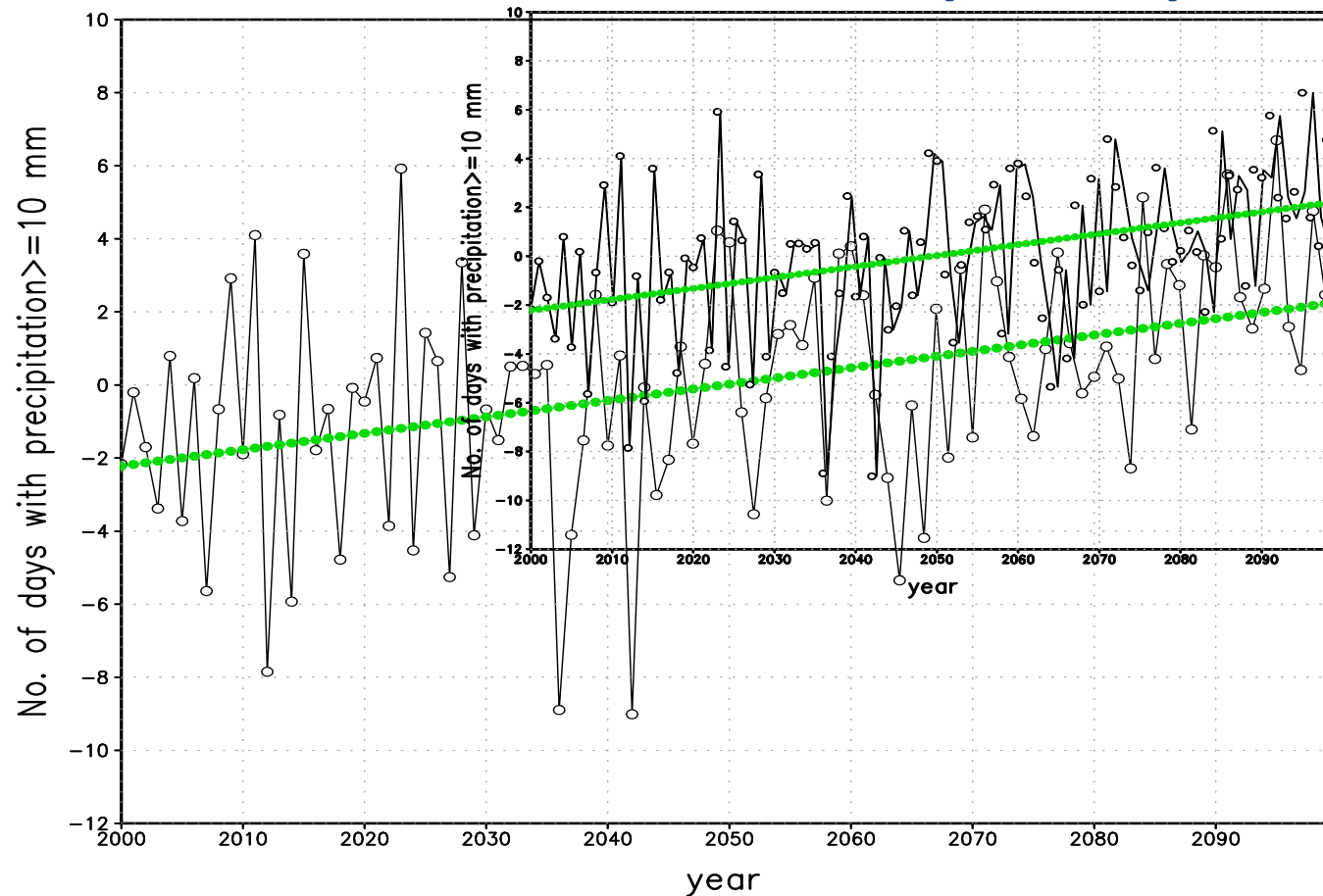
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## No. Of days with precipitation $\geq 10$ mm/d Direct measure of number of very wet days



### SRES-A1B CDD anomaly 20-30E, 35-25S



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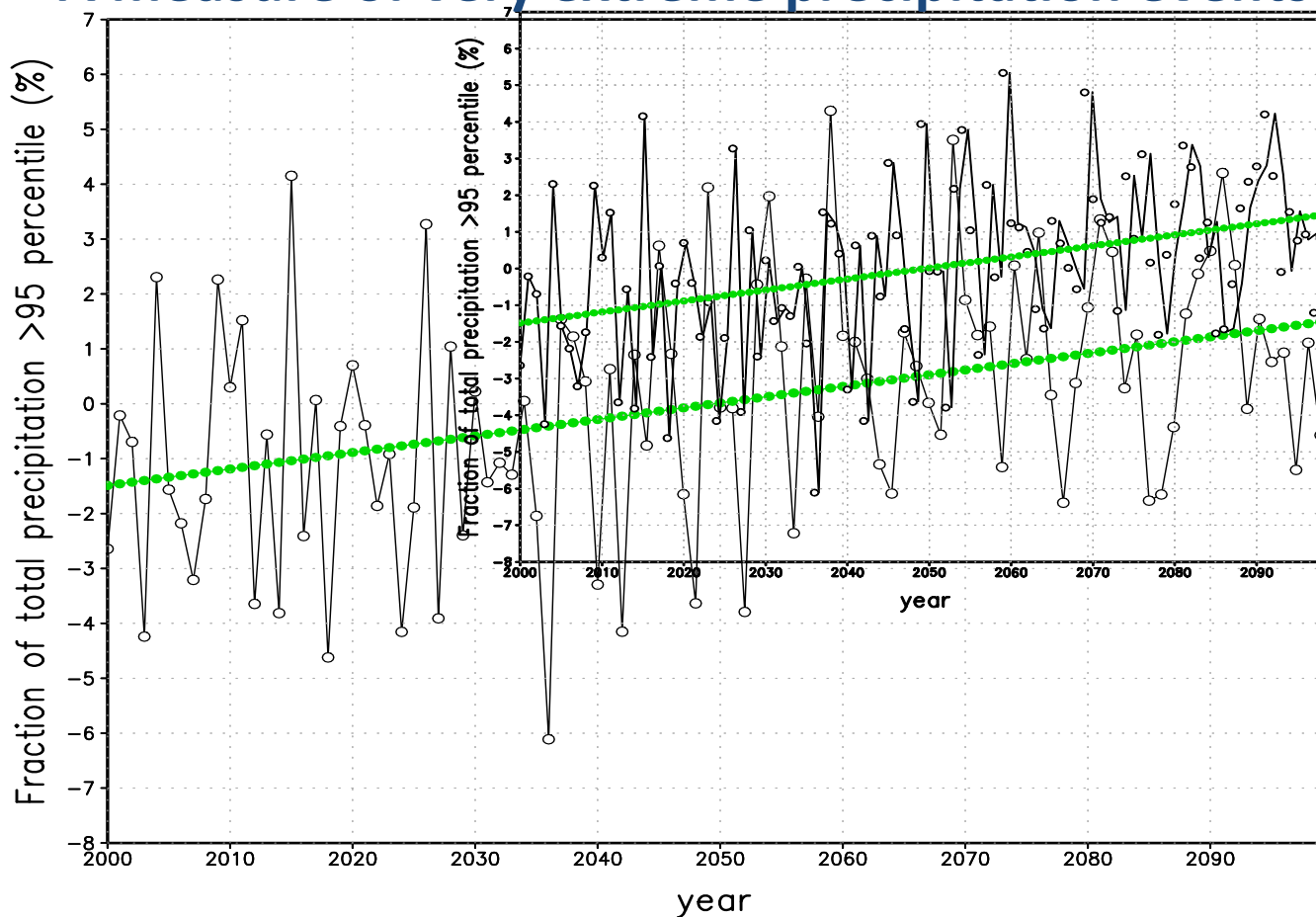




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# Fraction of annual total precipitation due to events exceeding the 1961-1990 95th percentile. A measure of very extreme precipitation events



## SRES-A1B CDD anomaly 20-30E, 35-25S



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## RegCM4 in SoCoCA

- Downscaling of CAM Oslo very important

## RegCNET and ICTP in SoCoCA

- A gateway to Southern Africa



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# Announcement PhD stipend

- Boarder between meteorology and hydrology
- Impacts of climate change
- Student at University of Cape Town
  - Supervisors: Tadross/Hewitson
  - Co-supervisors in Oslo: Tallaksen/Stordal
- CV and introductory letter to Stordal
  - [frode.stordal@geo.uio.no](mailto:frode.stordal@geo.uio.no)
  - Contact me during the workshop until Thursday



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**Thanks to:**

**Bamba Sylla, Filippo Giorgi (ICTP)**

**Lena Tallaksen, Sandeep Sukumaran, Johanne H  
Rydsaa (Univ Oslo)**







## □ Land features

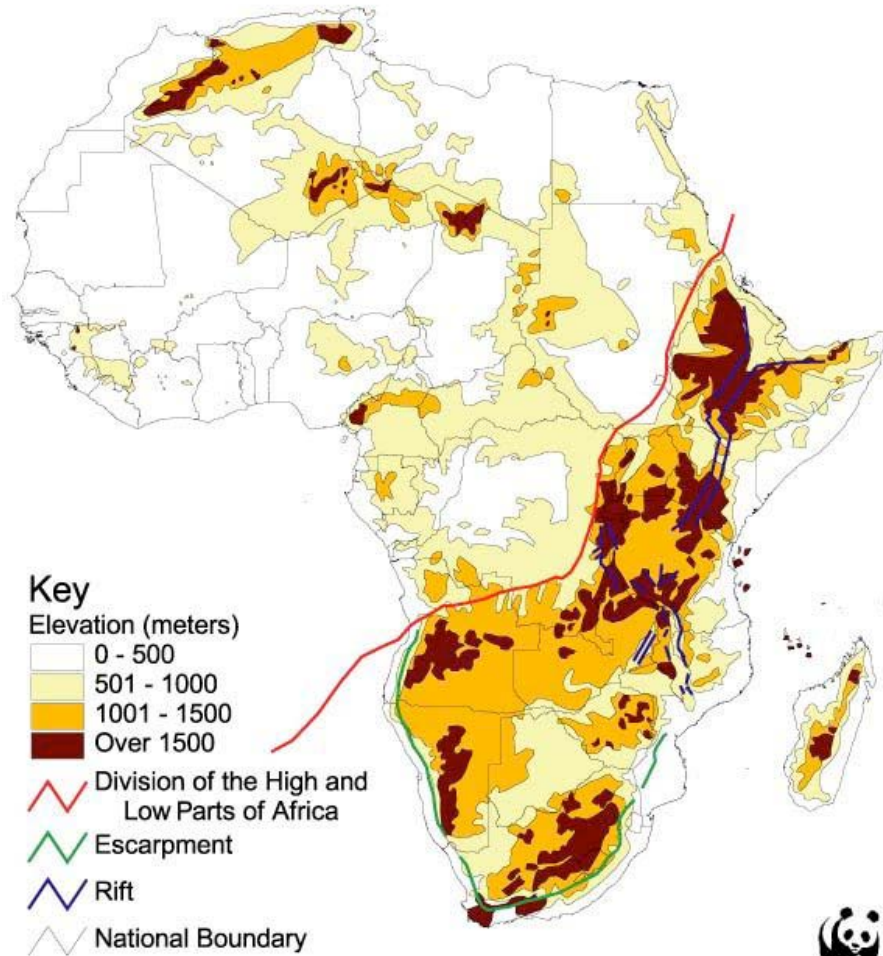


- ❖ Namib and Kalahari Deserts
- ❖ Great Rift Valley
- ❖ Lake Victoria
- ❖ Congo River Basin





## □ Elevation



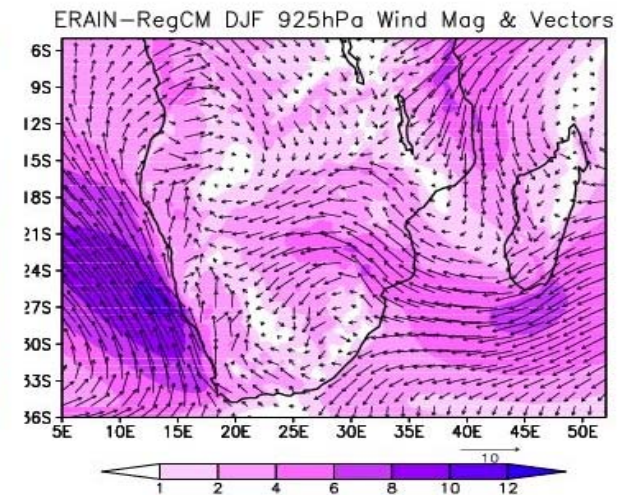
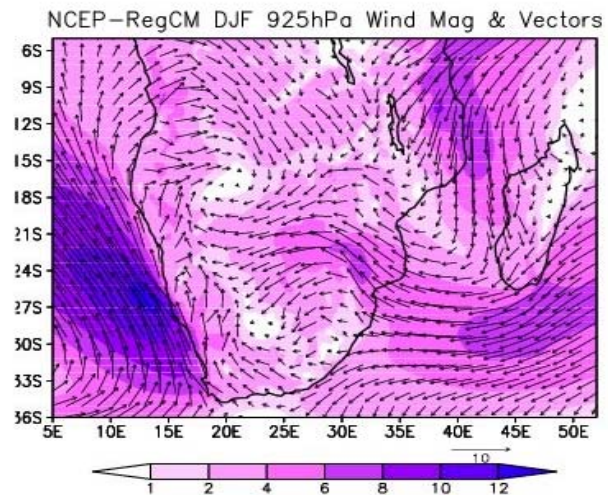
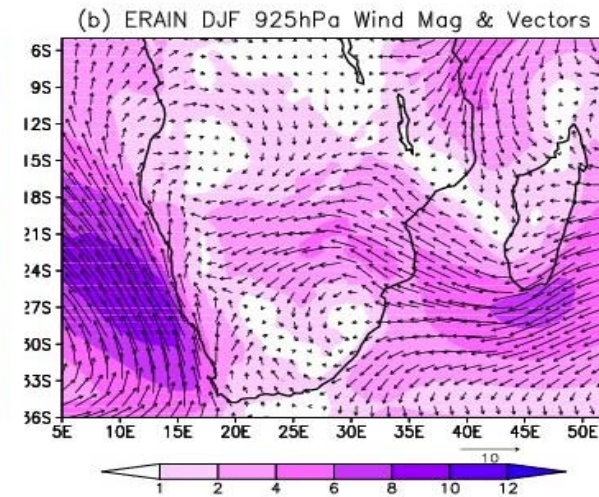
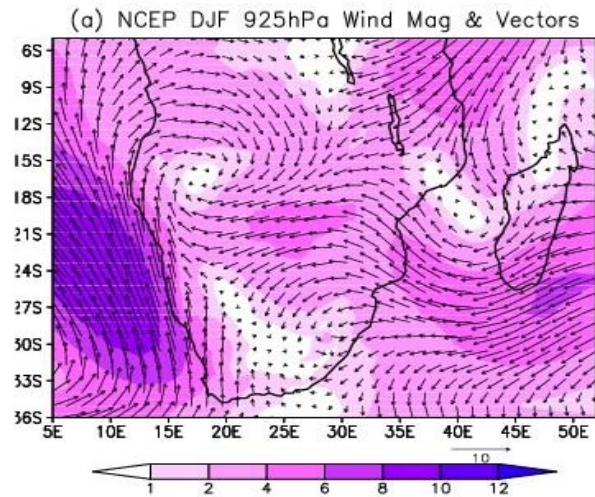
- ❖ Uplands everywhere
- ❖ Elevation boundary
- ❖ Sharp gradients







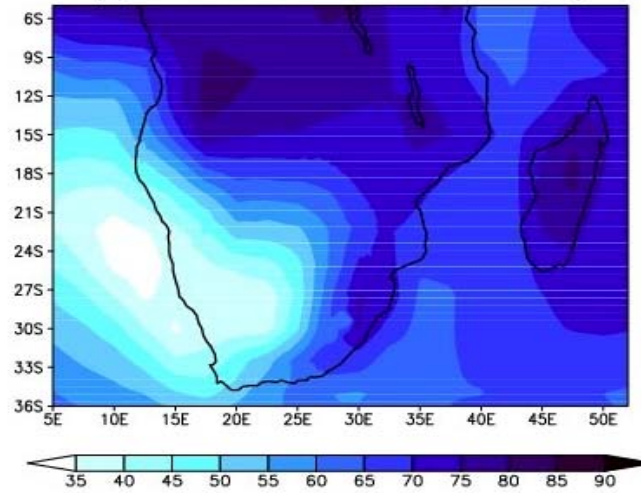
# ❖ Wind magnitudes and vectors



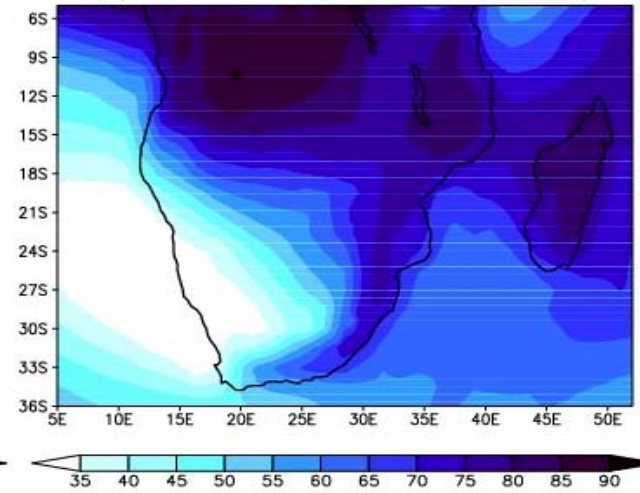


# ❖ Relative Humidity

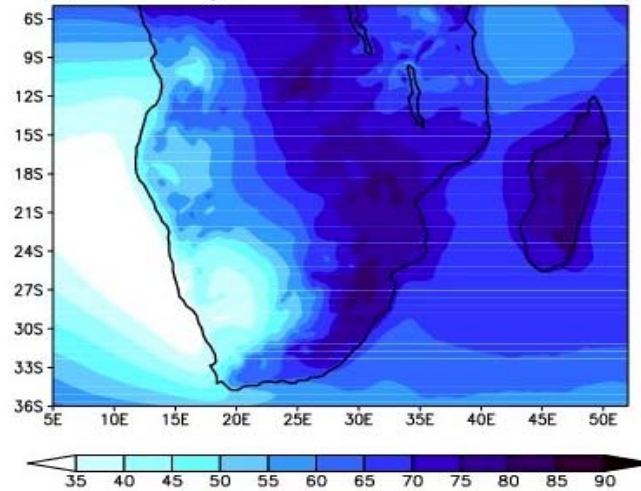
(a) NCEP DJF 850hPa Relative Humidity



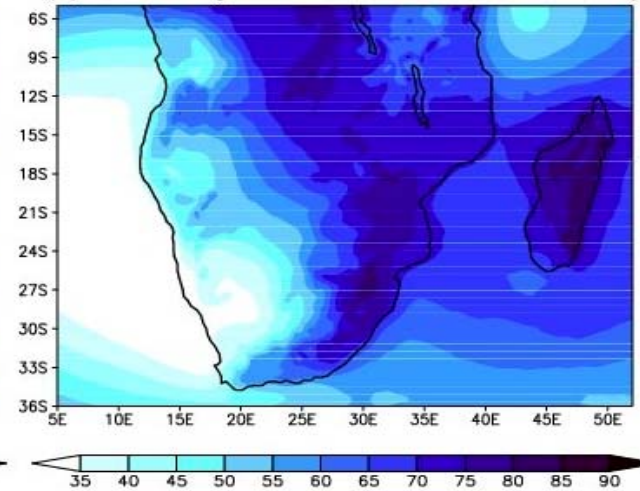
(b) ERAIN DJF 850hPa Relative Humidity



(c) NCEP-RegCM DJF 850hPa Relative Humidity



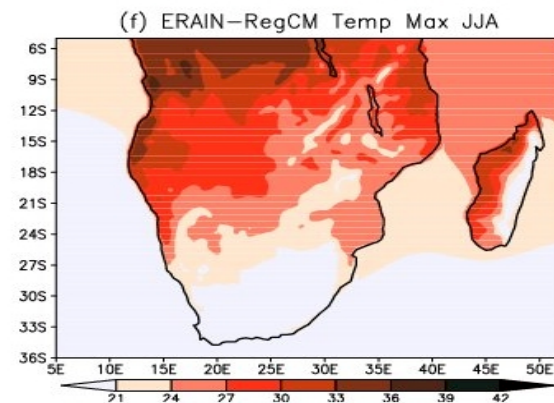
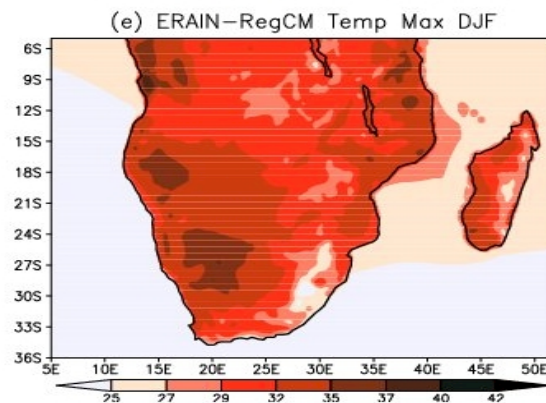
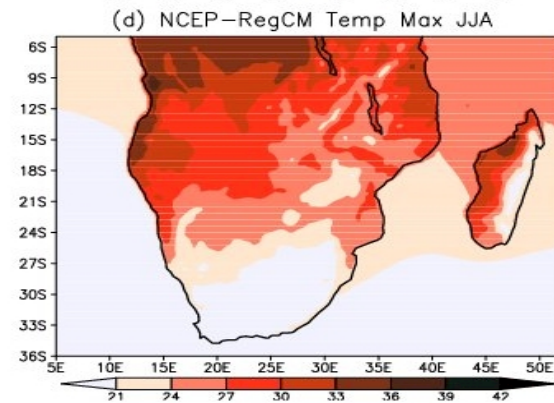
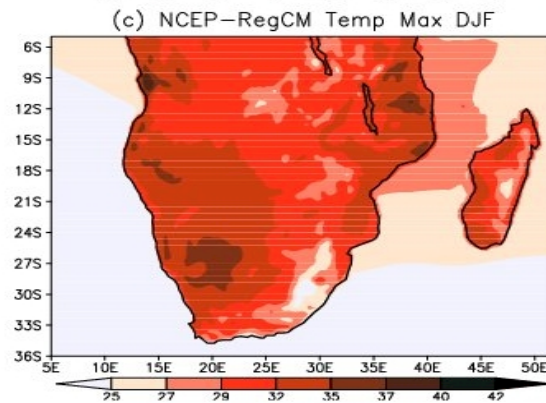
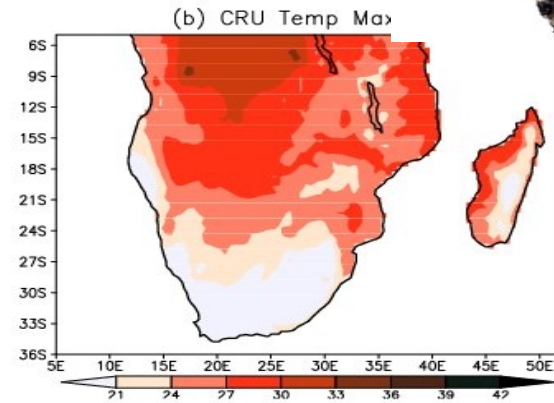
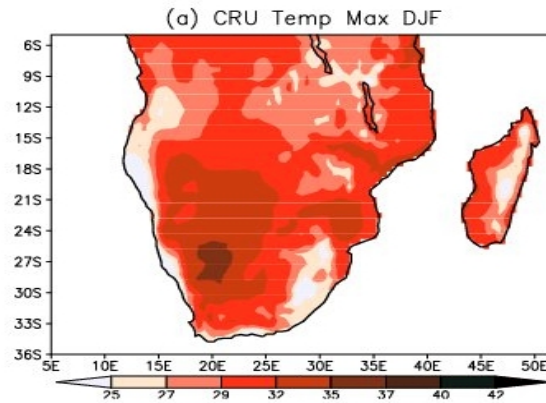
(d) ERAIN-RegCM DJF 850hPa Relative Humidity







# ❖ Maximum daily Temperature





# ❖ Minimum daily Temperature

