The SOCOCA Project and role of RegCM4 in it

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The SoCoCA project and the role of RegCM4 in it

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Contributions from:
Bamba Sylla, Filippo Giorgi (ICTP)
Lena Tallaksen, Sandeep Sukumaran, Johanne H Rydsaa (University of Oslo)
Rational for SOCOCA

Global climate
Regional climate
Hydrology
Agriculture
Economy
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
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

Department of Geosciences
# NUFU Project Network Team

<table>
<thead>
<tr>
<th>University</th>
<th>Contact Person</th>
<th>Other Team Members</th>
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</table>
| 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                                                                                                                                                                                   |
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.
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
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.
SoCoCA partners

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

Annual precipitation trends: 1900 to 2000

Trends in percentage per century:
- 50%  - 40%  - 30%  - 20%  - 10%  0  + 10%  + 20%  + 30%  + 40%  + 50%
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
Models in SoCoCA

- Global climate model: CAM Oslo (NCAR CAM3)
- Regional climate model: ICTP RegCM3/4
- Hydrological models: WASMOD
- Macroeconomic model: GRACE
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.
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.
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
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.
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
  - Fritsch and Chapel closure

- 2 Simulations: 10 years
  - NCEP
  - ERA-Interim
Mean Temperature
Precipitation
Macroscopical leaf lesions: stipples

bean
Ozone uptake by plants

- Only stomatal uptake
- No uptake through cuticle
- No uptake by roots
Population growth in Africa

Data source: Grübner et al. (2007), IIASA
Graphics: http://www.populationaction.org/
AFst0 O₃ (mmol m⁻²)
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 $O_3$ (mmol m$^{-2}$)

Period: 1.10.2000 - 30.4.2001 (daylight hours)
Maximum number of consecutive dry days ($R_{day} < 1\text{mm}$)

SRES-A1B CDD anomaly 20-30E, 35-25S
Maximum 5 day precipitation total
Potential flood indicator

SRES-A1B CDD anomaly 20-30E, 35-25S
No. Of days with precipitation \(\geq 10\text{ mm/d} \)

Direct measure of number of very wet days

SRES-A1B CDD anomaly 20-30E, 35-25S
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**
RegCM4 in SoCoCA

- Downscaling of CAM Oslo very important

RegCNET and ICTP in SoCoCA

- A gateway to Southern Africa
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
- Contact me during the workshop until Thursday
Thanks to:

Bamba Sylla, Filippo Giorgi (ICTP)
Lena Tallaksen, Sandeep Sukumaran, Johanne H Rydsaa (Univ Oslo)
- 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
- Maximum daily Temperature
Minimum daily Temperature