

Weather and Climate Modelling in South Africa

Russian Supercomputing Days
22 September 2024
Lomonosov Moscow State University

MM Bopape



science & innovation

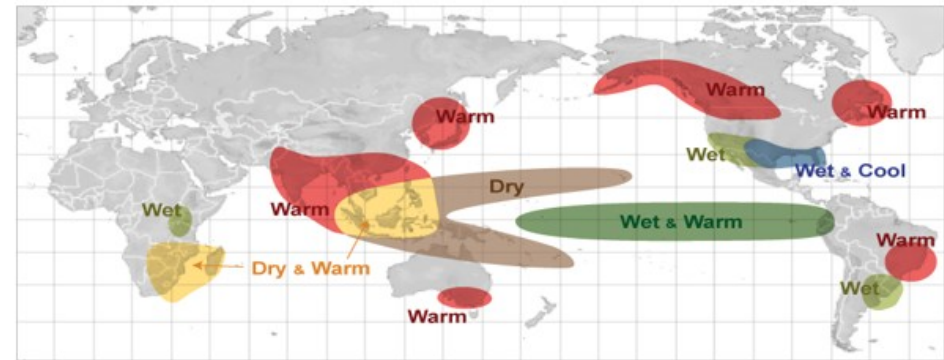
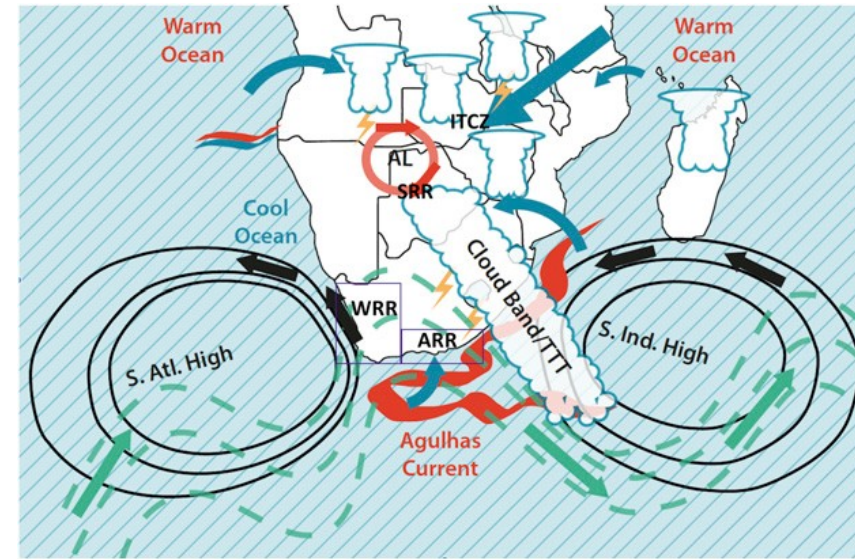
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Celebrating 25 Years of Research, Innovation, Impact and Partnerships

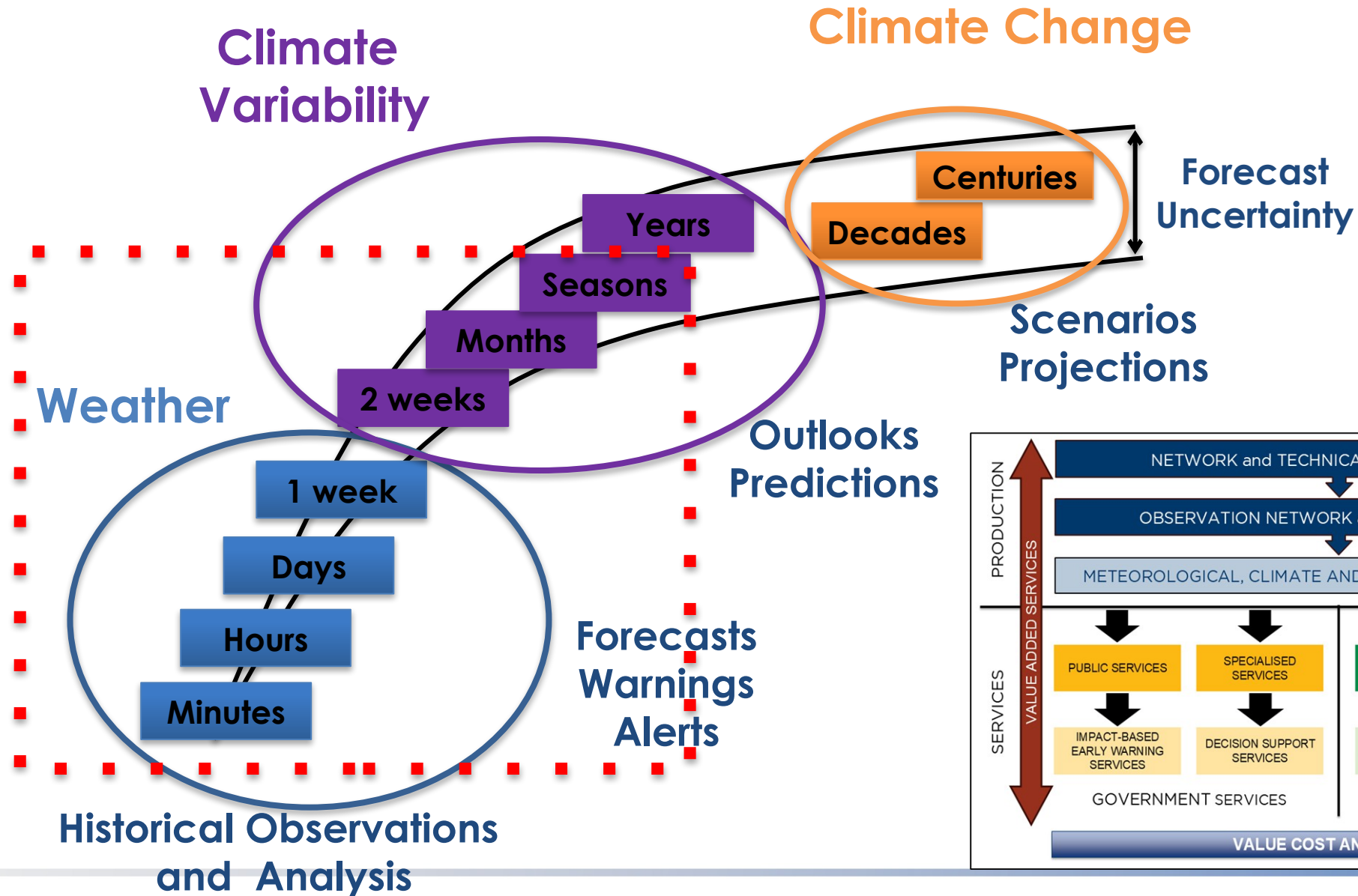


Weather Systems Influencing South Africa

- Location determines which systems impact us
- Subtropics drier due to dominance of high pressure (subsidence) – ridging high different with moisture transport
- Rainfall generally associated with low pressure systems (tropical and mid latitude cyclones)
- Proximity to Indian, Atlantic and southern ocean
- Teleconnections – far removed oceans - ENSO



Weather and Climate Services

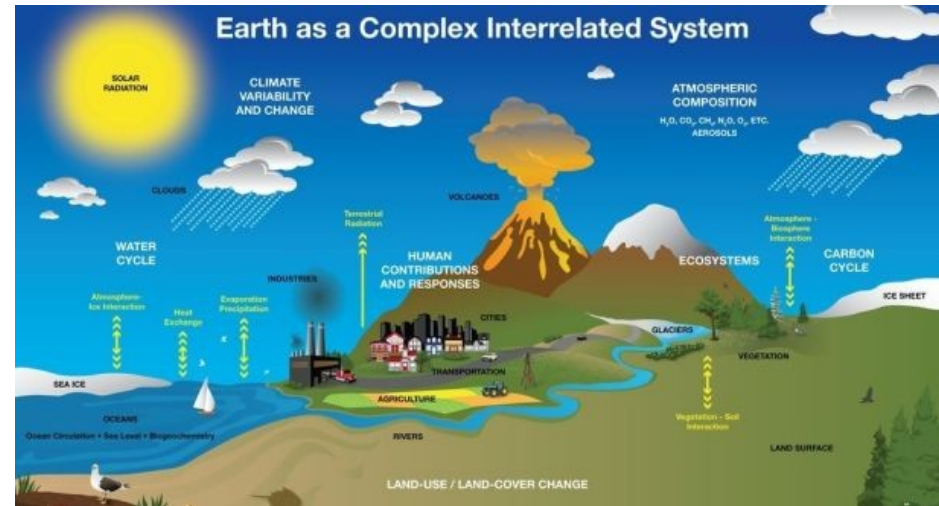
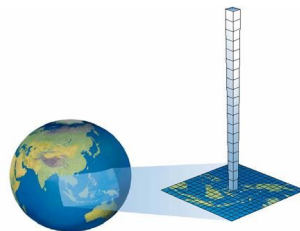
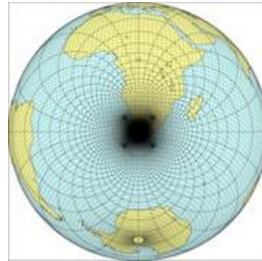
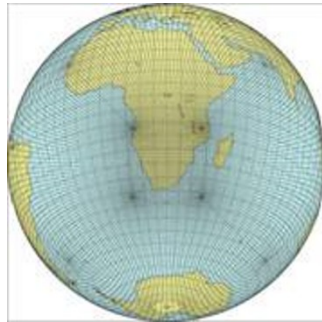
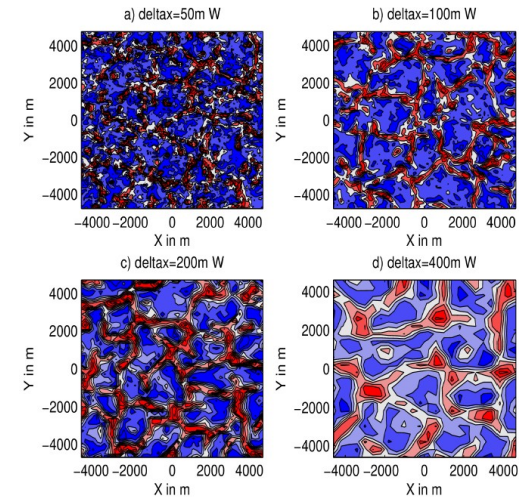


Numerical Modelling

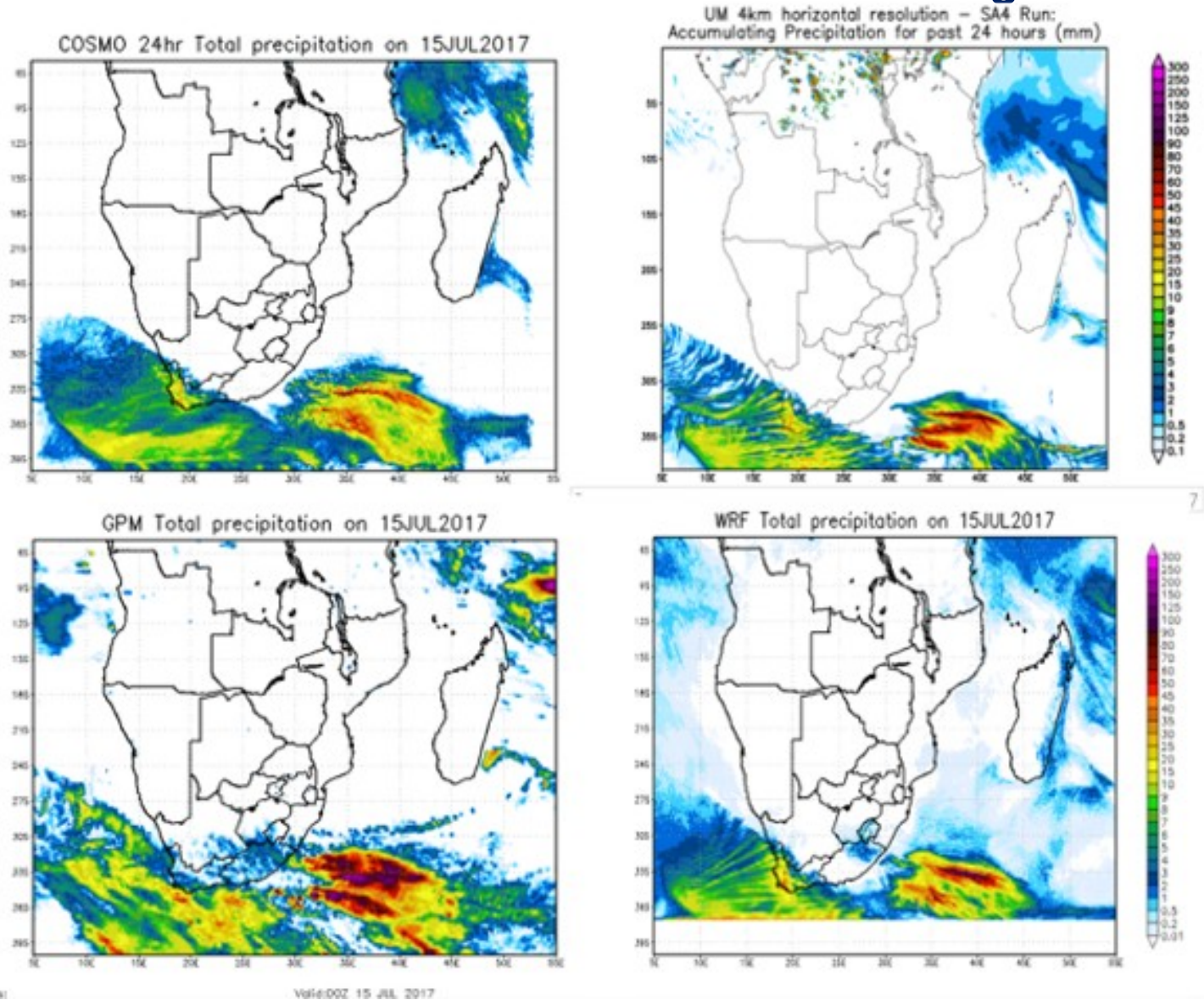
$$\frac{DV}{Dt} = -\frac{1}{\rho} \nabla p - f k \times V - gk + F$$

$$\frac{D\rho}{Dt} = -\rho \nabla \cdot V$$

$$c_p \frac{DT}{Dt} - \alpha \frac{Dp}{Dt} = 0$$

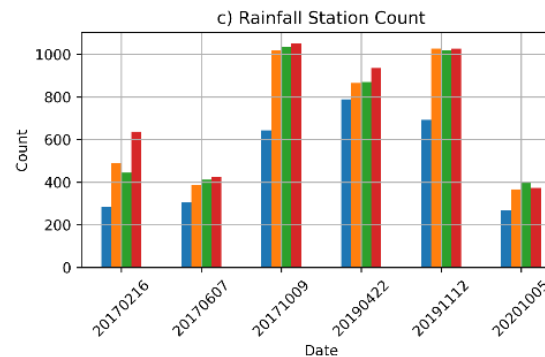
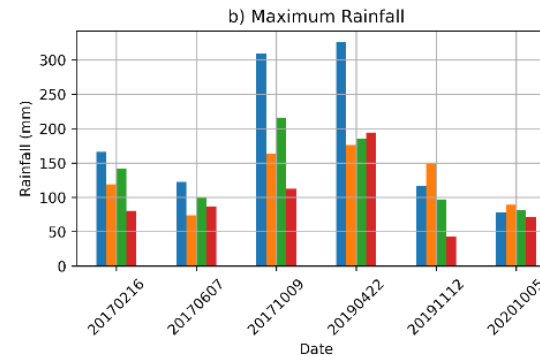
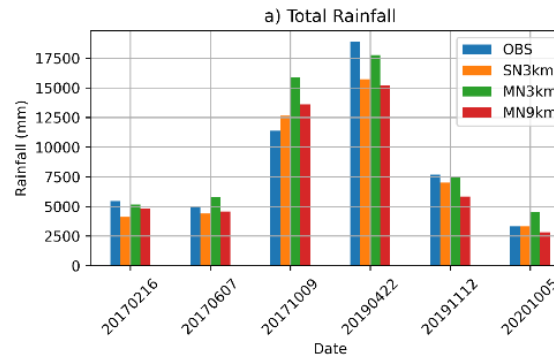
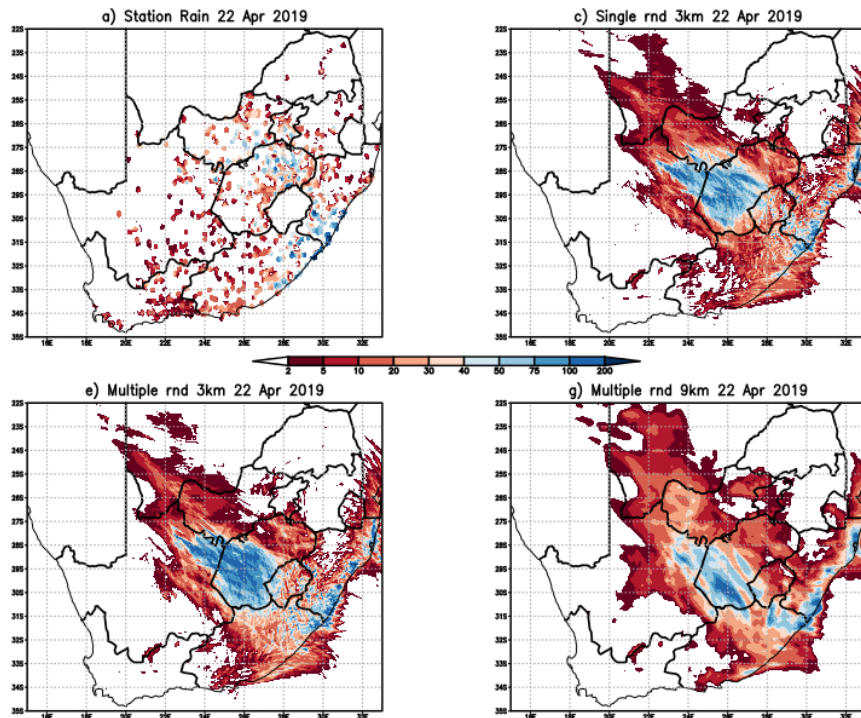


South African Context: Models running



- Many models in used for research and operations
- Global & downscaled
- Available computations resources:
 - Operational convective scale modelling
 - Operational seasonal forecasting
 - Climate change projections
 - Paleo climate studies
 - Sensitivity studies

Model shortcomings

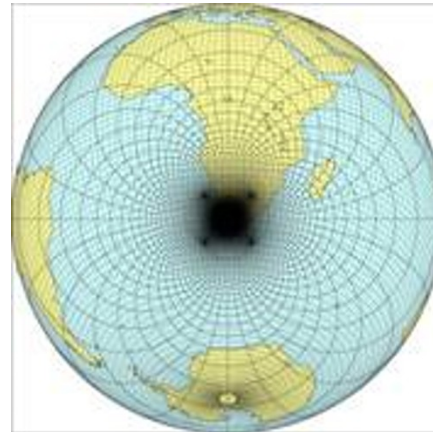
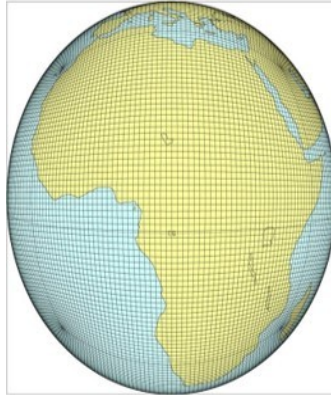


- Underestimation of the heaviest rainfall events
- Struggles with capturing location
- What do we do after we have picked up these challenges?

Model Development

On the development of a new nonhydrostatic atmospheric model in South Africa


F.A. Engelbrecht^{a,†}, J.L. McGregor^b and C.J. deW. Rautenbach^a



Recreating Earth through code

12 November 2019 - Schalk Mouton

The first Earth System Model developed and based in Africa are creating one of the most reliable and most detailed modulations of climate change.

 Check for updates

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Programme for the development of weather and climate numerical modelling systems in South Africa

Weather and climate numerical models have been in use in South Africa for many decades, both in operational and research mode.¹ All the models currently in use for operational purposes in the country were developed in developed countries. South African scientists started participating in the development or improvement of weather and climate numerical models in 2002, after being inactive in the area for over a decade.² The regeneration of model development activities started at the University of Pretoria through a Water Research Commission funded project in

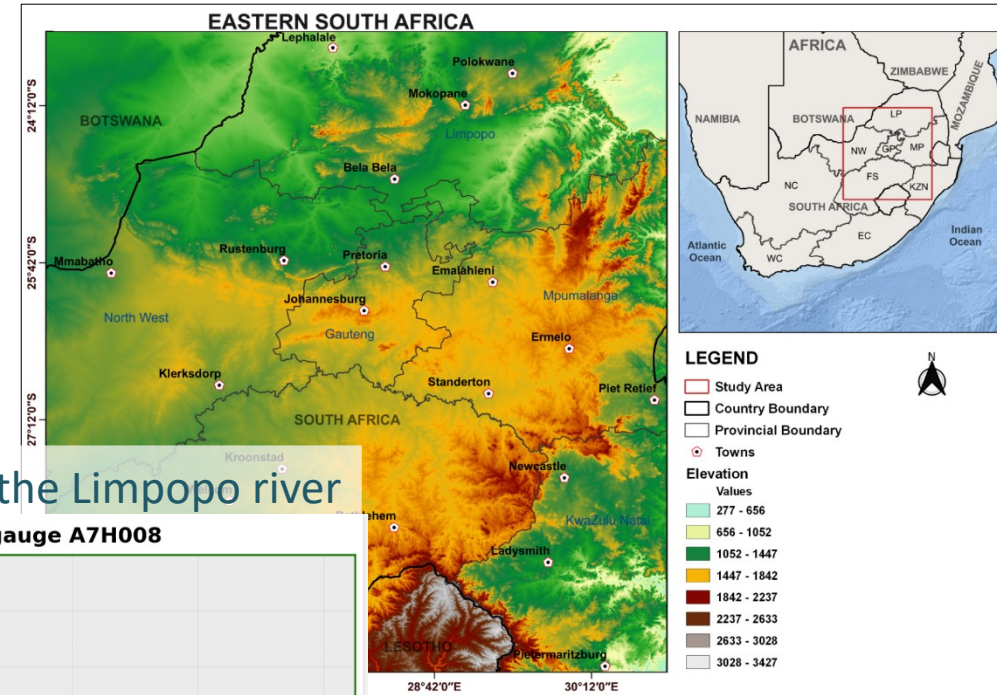
Engelbrecht FA, WA Landman, CJ Engelbrecht, S Landman, MM Bopape, B Roux, JL McGregor and M Thatcher, 2011: Multiscale Climate Modelling over Southern Africa using a variable-resolution global model. *Water SA*, 37, 647-658.

Simulation of South Africa streamflow over natural and urban landscapes using the INM RAS-MSU land surface model

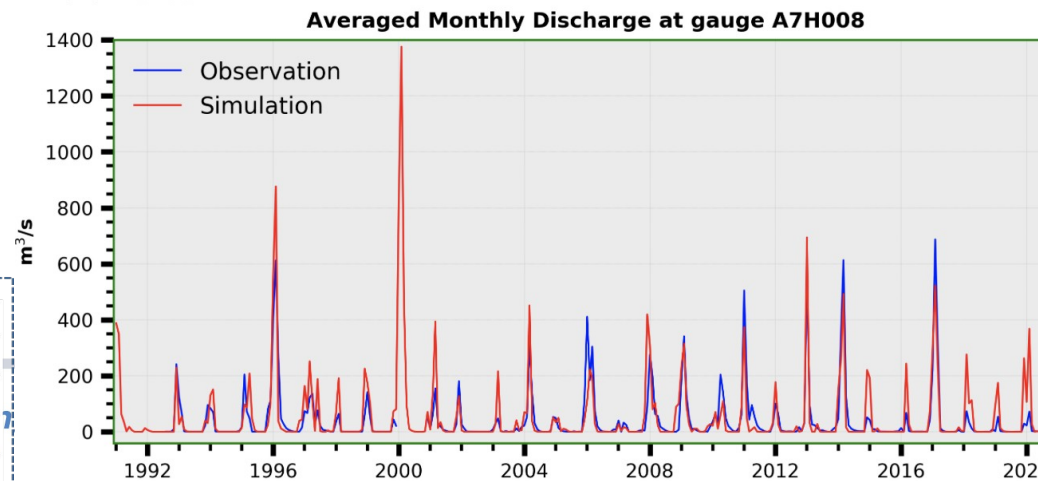
Candidate : Mr. T Mohomi
 Supervisor : Dr MM Bopape (NRF-SAEON)
 Co-Supervisor : Prof H Chikoore
 Dr VM Stepanenko (MSU, Russia)
 Prof I Dhau

Objectives:

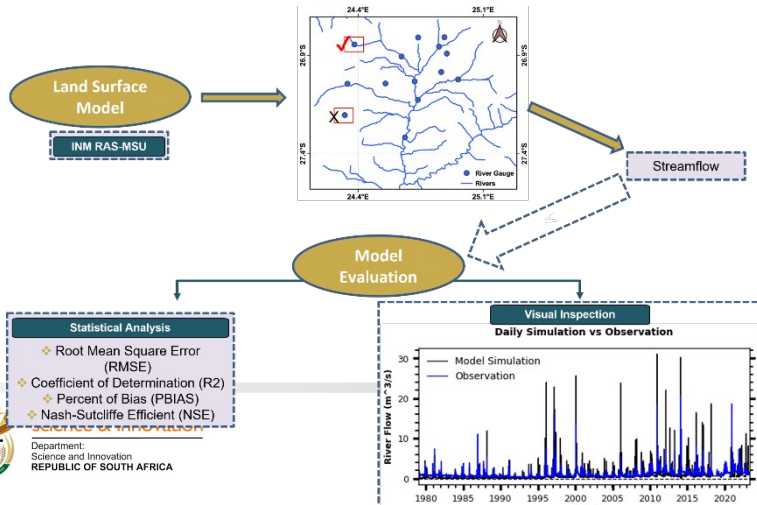
1. To evaluate the performance of the INM RAS-MSU LSM when simulating river flows in South Africa.
2. To study the sensitivity of the INM RAS-MSU LSM to spatial resolution.
3. To investigate the potential impacts of climate change on future river flows in South Africa (1979-2100).
4. To develop an urban scheme within the INM RAS-MSU LSM and simulate urban landscapes effects on surface hydrological processes in Gauteng.



TerM model performance for the Limpopo river



Eastern interior of South Africa



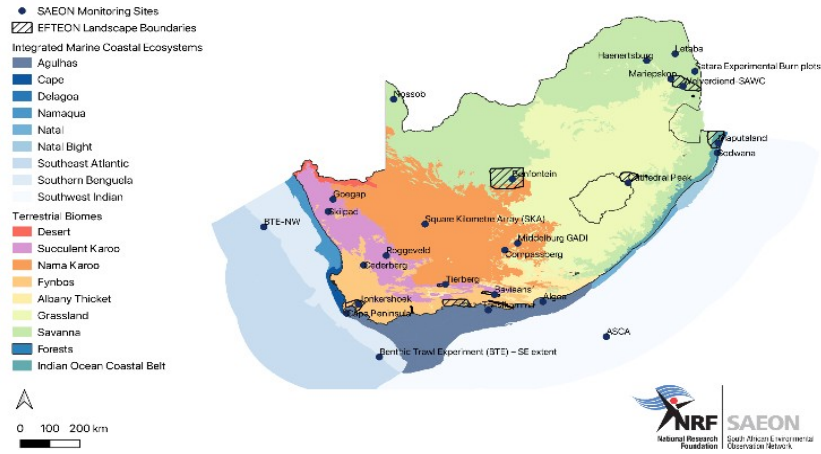
South African Research Infrastructure Roadmap (SARIR)

1. Expanded Freshwater and Terrestrial Environmental Observation Network(EFTEON)
2. Nuclear Medicine Research Facility
3. SA Network of health and demographic surveillance sites (SAPRIN)
4. National Centre for digital language resources
5. Shallow Marine and Coastal RI (SMCRI)
6. Natural Science Collection Facility
7. Distributed platform for Omics research
8. Biobanks
9. Biogeochemical research infrastructure platform
10. South African Polar Research Infrastructure
11. Nano-Micro Manufacturing facility
12. Solar research facility
13. Material characterization facility

National Integrated Cyber-Infrastructure cross cutting
(running models on CHPC cluster, SANReN – office location, DIRISA – data analytics)

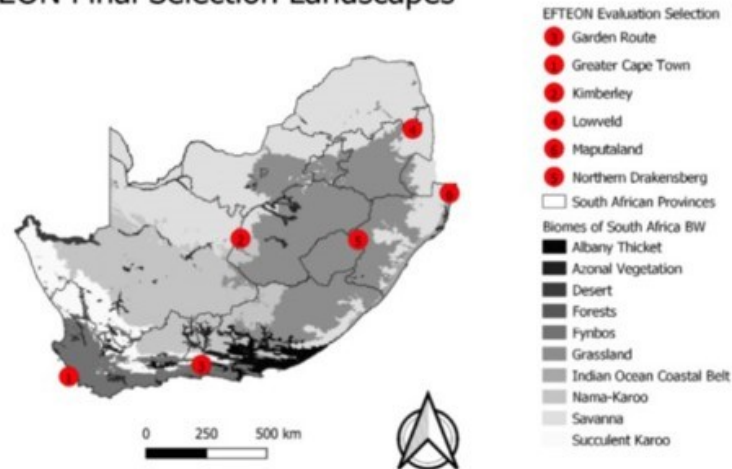


EFTEON, SMCRI and SAPRI – observations for verification

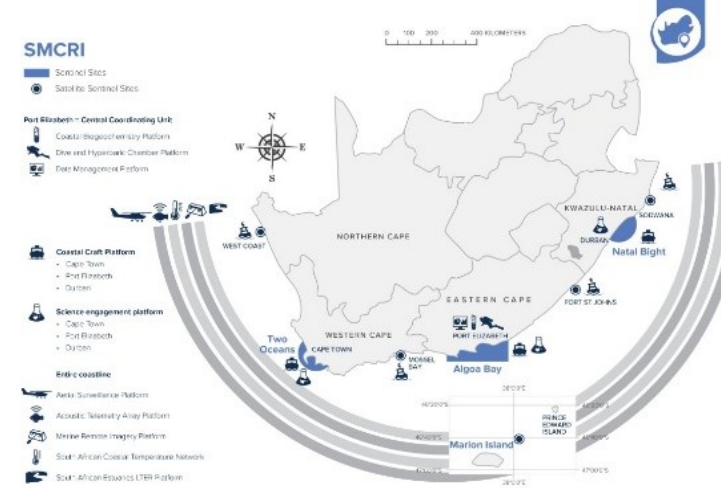


The Expanded Freshwater and Terrestrial Environmental Observation Network

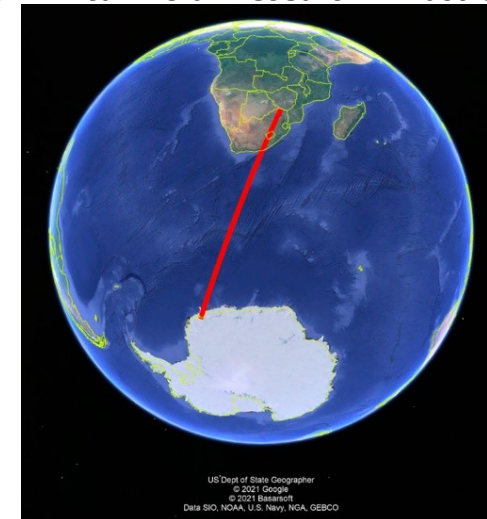
EFTEON Final Selection Landscapes



Shallow Marine and Coastal Research Infrastructure



South African Polar Research Infrastructure



Thank you

