

The Future of Africa's Wind Energy Sector Under 1.5°C and 2.0°C Global Warming.

¹Victor S. Indasi

²Chris Lennard, ³Grigory Nikulin, ⁴Alessandro Dosio

¹ACMAD. Niamey, Niger.

²CSAG. Cape Town, South Africa.

³SMHI. Norrkoping, Sweden.

⁴EC – JRC. Ispra, Italy.

“... Of all the forces of nature, I should think the wind contains the largest amount of motive power—that is, power to move things...as yet, the wind is an untamed, and unharnessed force; and quite possibly one of the greatest discoveries hereafter to be made, will be the taming, and harnessing of it.” –

Abraham Lincoln, 1860

Introduction

- ❖ Africa relies mainly on petroleum imports and hydropower to meet its ever increasing domestic and commercial energy requirements.
- ❖ Less than 40% of its population has access to electricity (World energy outlook, 2017) and the situation is aggravated by over reliance on hydropower which has often been unreliable, especially during dry seasons.
- ❖ The current global quest to reduce environmental impacts associated with fossil fuel use has necessitated considerable research into renewable energy with special emphasis on wind energy.

❖ With the Paris Climate Change Agreement, reached during COP21 set to cap the rise in global temperatures to 2°C officially into force, renewable energy sources are becoming even more important in the quest to reduce emissions (Carvalho et al., 2017).

❖ Wind energy generation provides a real opportunity for the continent to meet its energy demands, reduce environmental impacts associated with fossil fuel use and play its role in meeting emission targets set out during COP 21 in Paris.

Indeed several leaders from across the world acknowledge that renewable energy could be a major player in mitigating climate change during COP21 negotiations:

“Some of the sector-wide voluntary domestic measures and actions to address climate change include: Expansion in geothermal, solar, wind and other renewables and clean energy options. Close to two-thirds of our power at present is green. Our **310 megawatt Lake Turkana wind farm** will be the biggest such project in **Africa.**” President Kenyatta – COP21 Address – 30th Nov. 2015.

However, Wind energy resource is naturally a function of the climate system, susceptible to variations in climate and hence vulnerable to climate variability and change.

- In this study we:

- ❖ utilized current CORDEX Africa ensemble consisting of under Representative Concentration Pathway (RCP) 4.5 and 8.5:
- ❖ Analyzed the likely changes and patterns of surface mean wind speeds over Africa with a focus on **8 wind farms**, when projected global temperatures reach 1.5°C and 2.0°C.

Tanger.

140MW.126turbines.
2010.

Wind Farm Location

Zafarana. 303MW.

416turbines. 2001-2008

Ashegoda. 90MW.

54turbines. 2012

Adama. 153MW.

102turbines. 2015

L. Turkana: 310MW.

365turbines. 2017.

Tarfaya.

301MW.131turbines.
2014.

Gouda: 138MW. 46turbines.2015

Cookhouse: 138MW.

66turbines. 2014

Data

RCMs/ GCMs	BCC R- WRF 331C	CCCma- CanRC M4	CLMcom- CCLM4-8- 17	CNR- ALADIN 53	DMI- HIRAM5	MPI-CSC- or GERICS- REMO200 9	KNMI- RACMO2 2T	ICTP- RegCM4 -3	SMHI- RCA4	UQAM- CRM5
CNRM-CM5			45,85	45,85					45,85	
CSIRO-Mk3-6-0									45,85	
CanESM2		45,85							45,85	45
EC-EARTH (r1)							45,85			
EC-EARTH (r3)					45,85					
EC-EARTH (r12)			45,85			45,85			45,85	
GFDL-ESM2M									45,85	
HadGEM2-ES			45,85				45,85		45,85	
IPSL-CM5A-LR									45,85	
IPSL-CM5A- MR						85				
MIROC5									45,85	
MPI-ESM-LR (r1)			45,85			45,85		85	45,85	45
NorESM1-M	45,85				45,85				45,85	

Methods

- ❑ Global Warming Levels (GWLs): - the centre year of a 30-year period when global mean temperature reaches predefined anomalies (1.5 or 2°C etc.) relative to preindustrial levels (**1861-1890**) as it is available across all CMIP5 historical simulations (**Nikulin et. al., 2018**).
- ❑ Control – 1971 – 2000: - RCM data begins in 1950's and RCP scenarios begin in 2006. The corresponding 30-year period is then extracted from the downscaling RCM for analysis.

Results

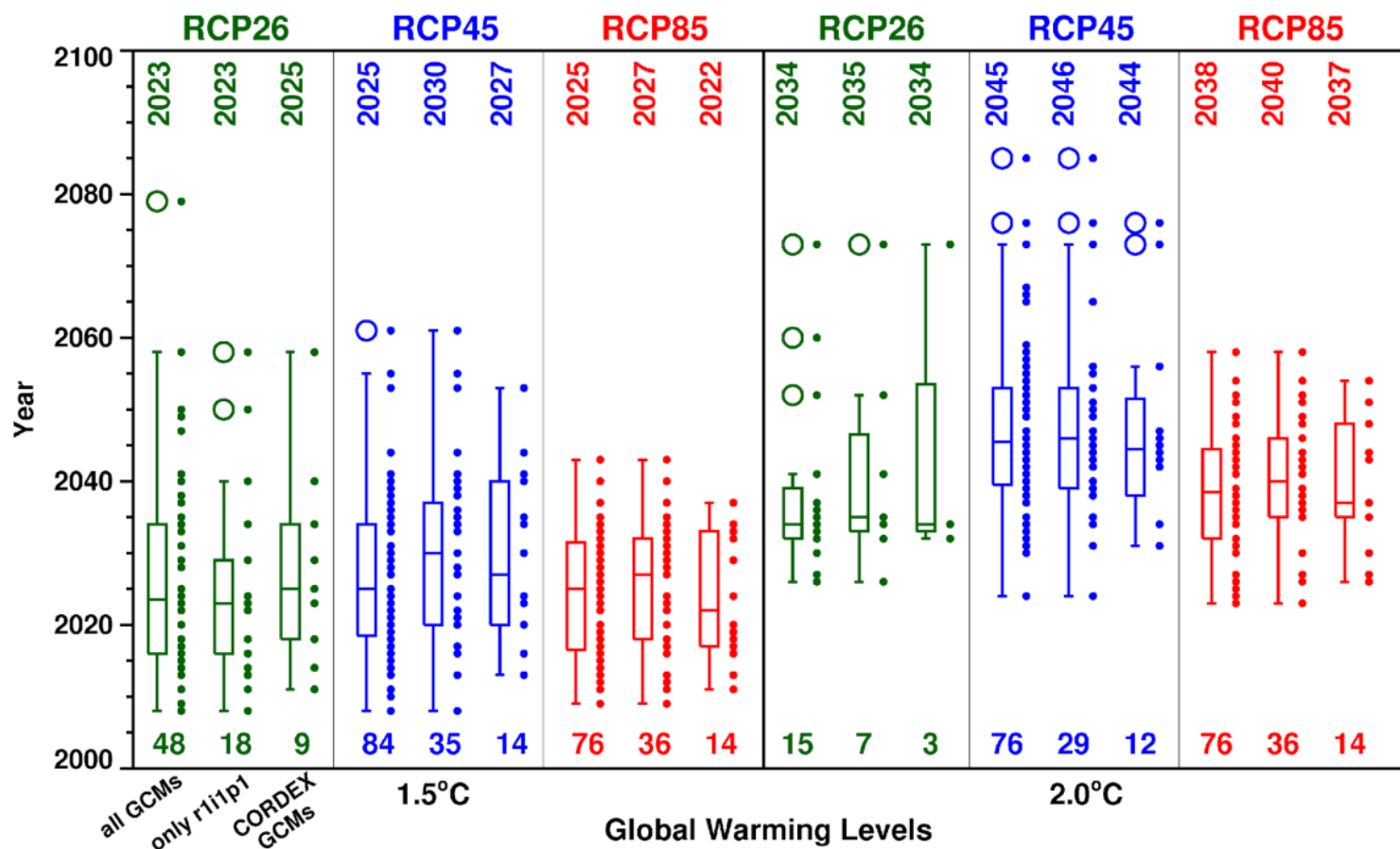
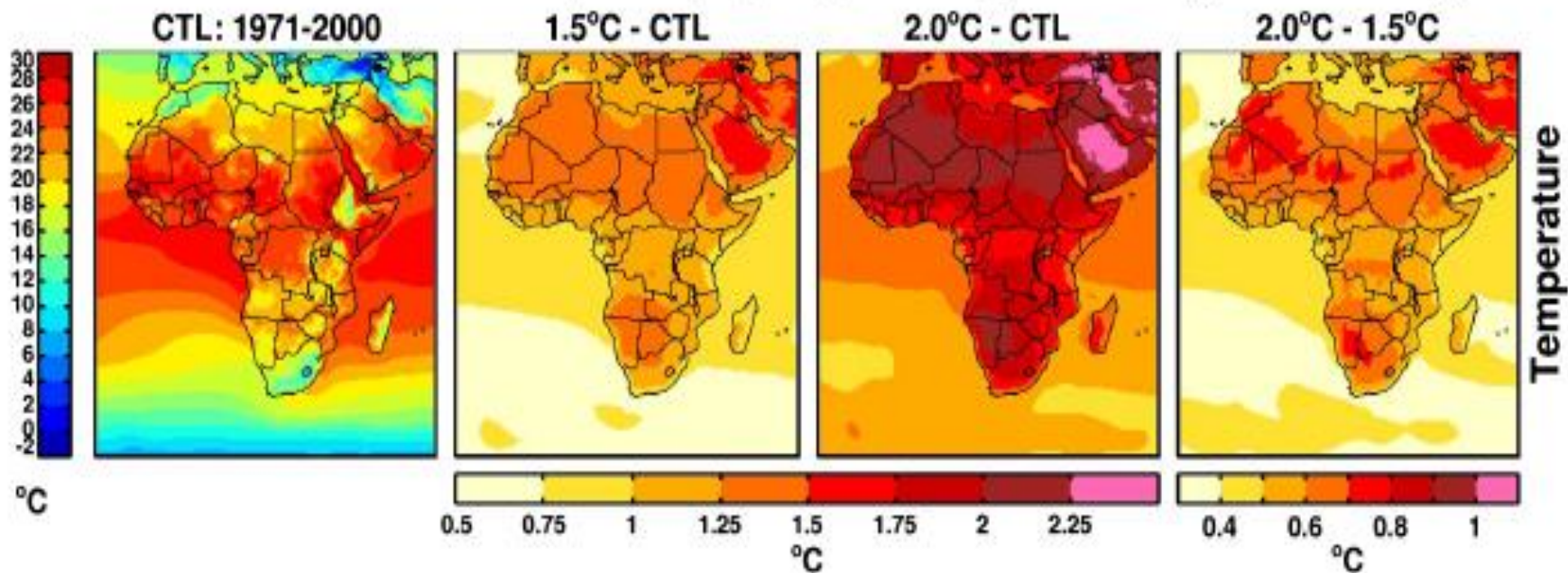


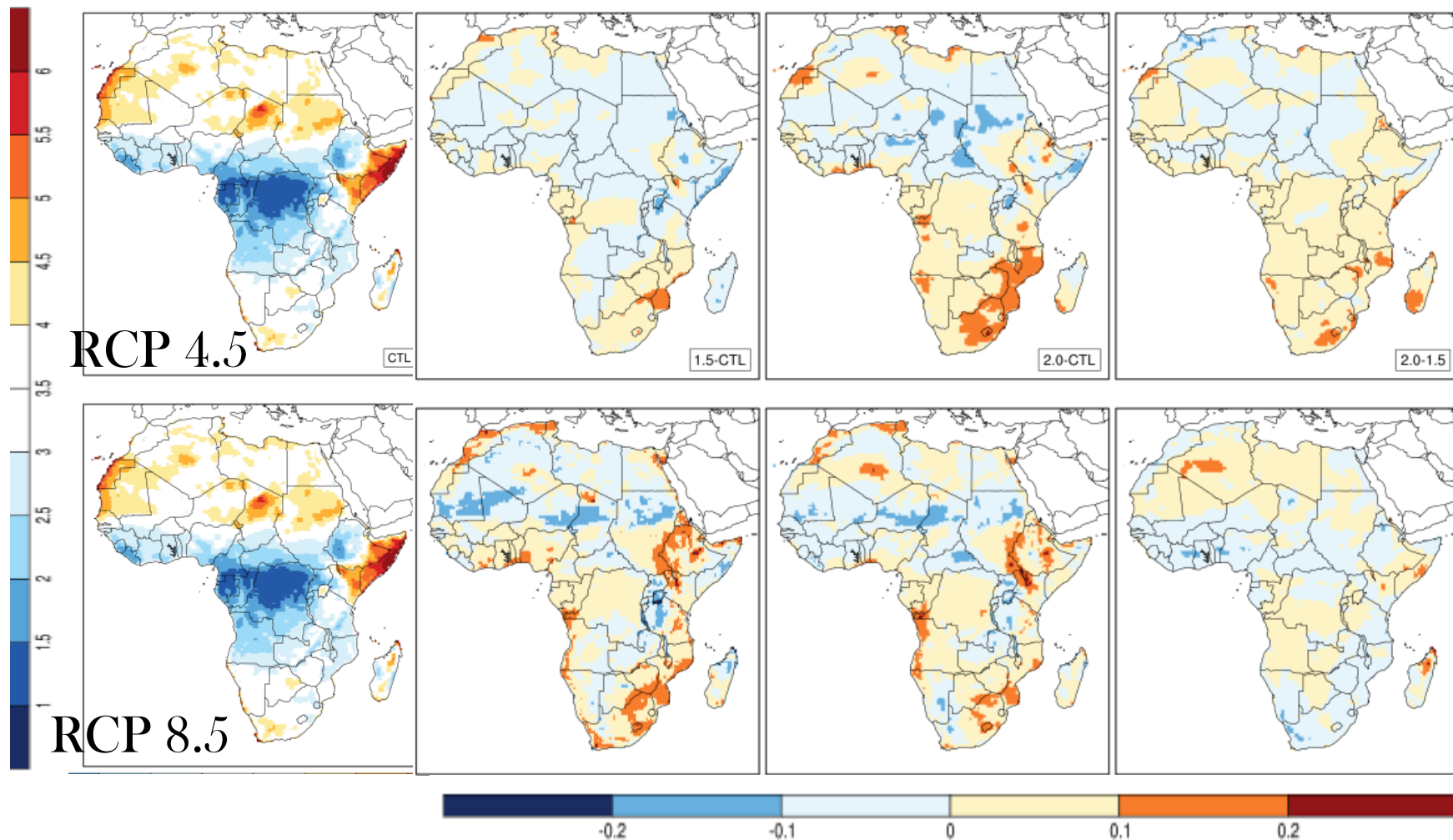
Figure 2. Timing of 1.5 and 2°C GWLs under 3 RCPs for the grand CMIP5 ensemble (left), only the first member for each GCM if there was an ensemble available (centre) and the GCM subset that used in CORDEX Africa (right). Numbers at the bottom show the number of GCM simulations reaching the 1.5 and 2°C GWLs and numbers at the top show the median year of GWL timing (Nikulin et. al., 2018)

25 CORDEX AFR-44 sim. | ANN | rcp85 | Hatching: 20 sim. (/) & SNR > 1 (\)



The CORDEX Africa ensemble average annual mean temperature and precipitation for 1971–2000 (CTL, left column), the projected changes at the 1.5 and 2° GWLs with respect to 1971–2000 (middle columns) and difference between the changes at 2 and 1.5° GWLs (right column) (Nikulin et. al., 2018).

Annual Mean Wind Speed



Country	Windfarm	RCP		Broad Implication
		4.5	8.5	
Ethiopia	Adama	↑ ↑	↓ ↑	Further research, actionable policies.
	Ashegoda	↑ ↑	↓ ↑	Further research, actionable policies.
Egypt	Zafarana	↑ ↑	↓ ↑	Further research, actionable policies.
Kenya	Lake Turkana	↑ ↑	↑ ↑	Actionable policies.
Morocco	Tanger	↑ ↑	↑ ↑	Actionable policies.
	Tarfaya	↓ ↓	↑ ↓	Further research, actionable policies.
South Africa	Cookhouse	↑ ↑	↑ ↑	Actionable policies.
	Gouda	↑ ↑	↑ ↑	Actionable policies.

Conclusions

- ❖ Africa region warms faster than the global mean, up to more than 1°C under the 1.5°C and ≥ 1.5 °C under 2 °C GWL compared to the control period (Nikulin et. al., 2018).
- ❖ Higher wind speeds projected at Lake Turkana, Tanger, Cookhouse & Gouda - wind energy potential for these eight regions is likely to persist under both 1.5°C and 2°C Global Warming Levels, thus sustainability of ongoing projects is guaranteed

❖ However, CORDEX simulations were **not designed** for wind energy applications – thus further research, with appropriate model configuration is required to fully uncover the benefits this sector could accrue from a changing climate.

❖ These results suggest that **actionable policies** geared towards fully utilizing increased surface wind speeds brought about by warming climate are needed especially in regions that have witnessed recent increased interest in wind energy.

***“The wind is an untamed, and
unharnessed force”***

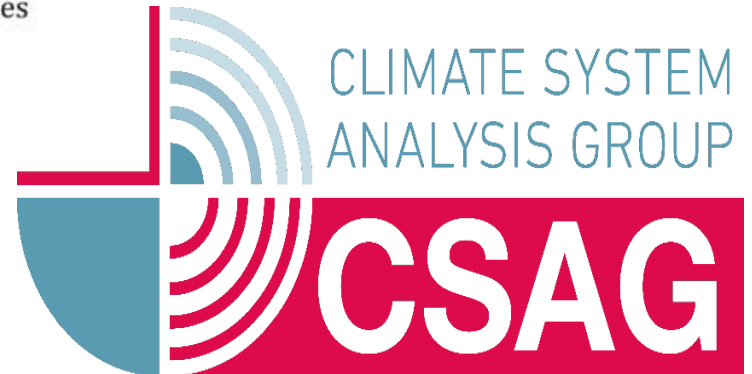
***The “future” is here let us harness
wind energy***

Acknowledgement



Sida

SMHI



Merci.

Thank you.