

ESM-forced hyper-high resolution seasonal wind speed predictions and implications for the renewable energy in a changing climate

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Presentation Overview

- Introduction
- Importance of Reliable Wind Speed Predictions
- Seasonal Wind Speed Prediction Applications
- A Review of Types of Prediction Models Frequently Used
- Envisaged Study Approach



Introduction

- Wind power is considered a significant emerging alternative energy source around the world because
 1. It provides access to a renewable and ecologically sustainable energy source as an alternative to fossil sources.
 2. It is less expensive.
 3. It plays a role in electric power generation systems
 4. Wind power generation systems' proliferation informs progress in implementation of global climate policy, hence, future climate decision making.



Source: ESI Africa (2019).

Importance of Reliable Wind Speed Predictions

- Wind speed is a fundamental variable in the wind energy sector for the operation of wind farms for wind power generation. The variable is influenced by multiple factors in a region such as the terrain, temperature, air pressure, and wind direction, etc.
- Future projections for wind energy have shown that climate change may alter the characteristics and variability of wind speeds on a seasonal timescale.
- There is a need for hyper-high resolution wind speed prediction systems to capture variations and cycles of wind speed for the improvement of predictive modelling performance which will foster effective use in informing renewable energy planning, operations and management strategies in the changing climate.
- The presence of errors in forecasted wind speed predictions for energy production create detrimental financial implications. According to Shouman (2022), a 1% error accounts for a \$12,000,000 loss.



Seasonal Wind Speed Prediction Applications

- Studies have outlined the advantages of using seasonal wind speed forecasting. These include;
 - Wind farm operation planning
 - The planning of electricity generation units for maximum power share.
 - Enhancing the evaluation process of wind speed characteristics for informing efficient renewable energy applications
 - Better economic dispatch planning and reliable transmission system operation



A Review of Types of Prediction Models Frequently Used

- Types of wind speed prediction models including;
 - (1) Physical model (Higashiyama et al., 2018)
 - (2) Statistical and computational models (Aly, 2020)
 - (3) Hybrid models (Aly, 2020; Yang et al., 2019)
 - (4) Artificial intelligence and machine learning models (Liu et al., 2020).
- Multiple authors have commended the performance of hybrid models in predicting wind speed as compared to single models (i.e., Kadhem et al., 2022; Liu et al., 2013), especially when combined with artificial intelligence technologies (Li et al., 2020).
- Hence, this study will apply hybrid models combined with artificial intelligence technologies (i.e., machine learning).



Envisaged Study Approach

- **Study Area**
 - Southern Africa and South Africa
- **Datasets**
 - Observed and reanalysis dataset to be used: ERA5 monthly wind speed near-surface (10 m) and upper surface (80-114m) datasets for a period of 15 years (2007-2020)
 - Model datasets to be used: CCAM model outputs of monthly wind speed near-surface (10 m) and upper surface (80-114m) datasets for a period of 15 years (2007-2020)
- **Method**
 - The study will apply both observed and reanalysis wind speed datasets to estimate potential wind power generator outputs.
 - An ensemble of process-based models' and data driven models (e.g., machine learning) forecasts will be used to estimate potential wind power generator outputs.
 - The observed wind power generation fields will be used to bias adjust systematic errors
 - The model outputs will be validated with wind power outputs from actual wind power generation sites.



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Thank you