# Renewable Energy Potential Estimates Based on High-Resolution Regional Atmospheric Modeling over Southern Africa with the ICON-LAM

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A major part of the global population without reliable electricity supply lives in Africa. Here, renewable energy is recognized as a sustainable, cost-efficient, and climate-friendly solution, especially, given the large unutilized wind and solar energy potentials across the African continent. Reliable, highly resolved information on renewable energy potential (REP) is imperative for planning. Often reanalyses like MERRA2 or ERA5 are used for the assessment of REP. However, those datasets typically have a relatively coarse spatial resolution, e.g., 30km for the ERA5 reanalysis. Aiming to provide more robust data at high spatial resolution, we propose a prototypical high-resolution dataset over southern Africa from dedicated atmospheric simulations. Results will be used to estimate REP with higher spatial precision compared to previous studies.

We have set up the ICOsahedral Nonhydrostatic (ICON) Numerical Weather Prediction (ICON-NWP) model v2.6.4 in its Limited Area Mode (ICON-LAM), based on an operational weather forecasting configuration. ICON-LAM dynamically downscales global deterministic ICON-NWP forecasts with a grid spacing of 13km to a convection-permitting resolution of 3.3km, inscribed into the coarser grid, without deep convection parameterization. Simulations cover the time span from 2017 to 2019 with contrasting meteorological conditions. To keep the ICON-LAM close to the observed atmospheric state, which is assimilated into the driving global ICON-NWP runs, the ICON-LAM's atmosphere is reinitialized every 5 days, with a preceding spin-up of one day. The land surface and subsurface are run transiently. Southern Africa is chosen as our focus area due to its favorable solar and wind conditions.

Simulated 10m wind speed, surface solar irradiance, 2m air temperature, and precipitation are evaluated using satellite data, composite products, and in-situ observations of three networks (SASSCAL, TAHMO, and NCEI). Initial results indicate that our ICON-LAM simulations can reliably reproduce observations. Typical seasonal characteristics in austral winter and summer are reproduced. Further investigation on in-situ observations at an hourly resolution for three simulation years shows encouraging results. Most of the simulated 10m wind speed biases (Model - OBS) are positive with an average mean error (ME) of 1.12 (± 0.83) m s-1. The correlation coefficient (R) between observed and simulated 10m wind speed is larger than 0.6 for 69% of the observation sites. Biases in simulated daytime surface solar irradiance have an average ME of 51.39 (± 63.35) W m-2. The linear correlation between simulated and measured solar irradiance is above 0.8 over most of all sites. We also find a mall bias with an average ME of 0.23 (± 0.99) °C in simulated air temperature and an increase of simulated monthly precipitation biases from West to East of the model domain. In an ensuing step, this high-resolution ICON-LAM simulation product will be used to derive REP.