

DEVELOPMENT OF AN ONLINE MAPPING APPLICATION TO ASSESS WIND SPEEDS IN THE 21ST CENTURY USING REGIONAL CLIMATE MODEL SIMULATIONS

Introduction and Motivation

Over the past decade, climate scientists have given attention to the application of Regional Climate Model (RCM) scenario simulations to assess the future quantity and distribution of wind as an energy resource. Given the decadal lifespan of wind turbines, simulations of future wind conditions up to the end of the 21st century can provide interested parties with a glimpse into possible returns not only based on the current climate, but also accounting for potential climatic changes.

The primary goal of this work is to produce a prototype web application based on RCM output, to be used for the spatial evaluation of future wind speeds. Included in the work is an assessment of currently available online applications and web services for the assessment of wind energy, as well as those for visualizing climate model output. Furthermore, a partially automated workflow for batch processing climate model output in NetCDF format to be shared as web services in the ArcGIS Online (AGOL) framework is established. This workflow promotes continued work and advancements on the web application conceptualized here. Several climate model simulations from the ongoing EURO-CORDEX project are utilized for creating the workflow and prototype application.

Contribution

- In comparison to existing web applications for planning wind energy, the prototype developed here utilizes regional climate model simulations for future periods, driven by GCM boundary conditions, rather than reanalysis simulations created with observation data.
- The developed workflow is reusable and can be further applied to expand the prototype application presented here.
- The web services produced for the prototype application developed here additionally provide new content for AGOL. This work introduces regional climate model simulations of wind speed across Europe for a future period.

Methodology

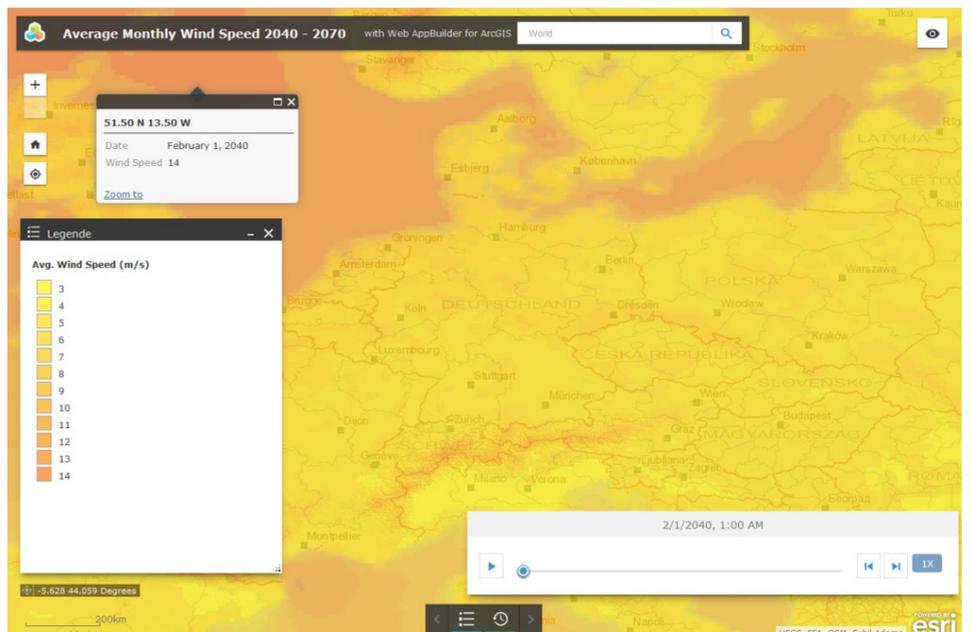
- Simulations of wind speed at a monthly interval between the years 2040 and 2070, produced by Regional Climate Model downscaling, have been downloaded. Data from 5 different models within the ongoing EURO-CORDEX project has been used in this work.
- Four Python scripts for processing the acquired data, downloaded in NetCDF format, have been written. Through an iterative function, raster-based datasets, the average wind speed provided by 5 models on a monthly frequency over 30 years, were created. The resulting 360 rasters were organized within a time-aware Mosaic Dataset.
- From the Mosaic Dataset, a time-aware Image Service was created and hosted using an ArcGIS Server. From this service, new content was introduced to AGOL.
- The Image Service, as well as two other created services, were utilized within a web application hosted on AGOL, configured using the Web AppBuilder. The purpose of the application is to assess future wind speeds as relates to wind energy potential.

Tools

- The Linux-shell emulator Cygwin and the toolset CDO have been used to access and manipulate data in NetCDF format.
- Python and specifically the modules Numpy and ArcPy have been used to develop a workflow to batch convert NetCDF files to an ArcGIS format. The ArcGIS version used is 10.3.
- An ArcGIS Server is used to share the created datasets as web services, and the Web AppBuilder is used for configuring the web application.

Conclusion

- The Mosaic Dataset and Image Service have proven to be useful tools for storing and sharing time series data derived from RCM simulations. Further work on this application within the AGOL framework should focus on these tools.
- Further development of toolkits for working with the NetCDF format in Windows and ArcGIS Desktop would benefit users wishing to work with RCM output.
- This work has successfully introduced the application of RCM simulations to web applications for assessing renewable energy resources. The prototype application may be used for generating interest in such an application.
- Continued development stemming from this work should include additional variables, scenarios and models. The integration of RCM simulations alongside the traditionally used reanalysis simulations within an application for assessing renewable energy resources should also be explored.



A screenshot of the prototype web application in which the time-aware Image Service is visible, as well as the time slider, legend, and pop-up.

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